THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE III. VOL. VII.

No. VIII.—AUGUST, 1890.

ORIGINAL ARTICLES.

I.—On the Occurrence of the Genus *Turrilepas*, H. Woodw., and Annelid Jaws in the Upper Silurian (? Wenlock) Rocks of New South Wales.

By R. Etheridge, jun.,
of the Australian Museum, Sydney, N. S. Wales.

(PLATE XI.)

THE correspondence in the life of the Wenlock rocks of Great Britain and those probably occupying a similar horizon in New South Wales is a very marked one. At present, I wish more particularly to draw attention to the occurrence of the genus *Turrilepas* and Annelid jaws in the Bowning Beds of New South Wales. This series of rocks has been enthusiastically investigated by Mr. John Mitchell, who, in his capacity of Teacher of the Public School of that place for some years, had an excellent opportunity of working out the fauna of the series in question. His researches are detailed in two papers, "Notes on the Geology of Bowning,"[1] and "The Geological Sequence of the Bowning Beds."[2] Both the plates of *Turrilepas* and the small Annelid jaws are found in the Lower Trilobite bed[3] of this series, and are chiefly from the typical locality of Bowning Creek.

Plates of Turrilepas. Pl. XI. Figs. 1–5.

At an exhibition of some of the more characteristic of the Bowning fossils at a meeting of the Linnean Society of New South Wales held on June 29th, 1887,[4] Mr. Mitchell showed a few plates of *Turrilepas*, as determined by myself, and this is the first record of its occurrence in Australia, so far as I am aware.

Two or perhaps three forms of plate have been obtained at Bowning, including that termed by the late M. Barrande the 'cancellated plate' (Figs. 4 and 5), and a specimen split in half, and probably representing the entire organism, with the plates displaced generally. The outline (Fig. 1) does, however, so far approximately correspond with that supposed to represent a perfect *Turrilepas*, that I think the plates may be looked upon as more or less *in situ*. In their disunited condition they form a long, slender, sack-like body,

[1] Proc. Linn. Soc. N. S. Wales, 1887, vol. i. (2), p. 1193.
[2] Report, Austr. Assoc. Adv. Science for 1888 [1889], vol. i. p. 291.
[3] *Ibid*, p. 294.
[4] Proc. Linn. Soc. N. S. Wales, 1887, vol. ii. pt. 2, p. 414.

one inch and an eighth in length, by an eighth in width. Only the impressions of two plates are present. If this represents anything approaching the form of the original organism, it certainly differs from any with which the writer is acquainted. There are traces of four rows transversely, and from twelve to fifteen in a row longitudinally, but the entire *Turrilepas* is not preserved.

The proportions of the individual plates are different to those of the English Wenlock species, *T. Wrightii*, de Kon., sp.,[1] being much more elongated and very slender, and the growth imbrications finer and closer. Some of the plates, as in Fig. 1, are not unlike *T. Scotica*, mihi,[2] only wanting the extreme kite-like outline of the latter, and fine drawn-out superior end.

The plates contained in this slender body, Fig. 1, I believe to represent a different species to that represented by Fig. 3. The latter agrees better with *T. Wrightii*,[3] or an undescribed species which occurs in the Wenlock rocks of the Pentland Hills, N.B., than it does with either of the Bohemian species. The subject of Fig. 3 is a short, obliquely deltoid, or triangular, very inequilateral plate, strongly carinate excentrically, and with a short pointed apex, the lower margin being doubly sigmoidal, like the successive surface imbrications, which are much coarser in this form of plate. These transverse lines describe two unequal sigmoidal curves in their course across each plate.

In a third form of plate, not figured here, the carina is central and narrow, the surface on one side plain, the other with very marked imbricating laminar striæ deflected downwards almost at a right angle to the carina, and strongly denticulating the margin of the plate.

Several cancellated plates occur, but there is no resemblance between them and those figured by Barrande from Bohemia,[4] or *T. Scotica*, mihi. The cancellated plates are elongately triangular-oval, the carina simple, and slightly excentric. The imbricating laminæ are distant, except along one margin, where they suddenly become parallel to the latter, and are quite contiguous to one another. Towards the narrower end of these particular plates the laminæ become concentric, thus cutting off the apical portion, which is depressed and round, although not perfectly central, nor truly apical as regards the margin of the plate.

To sum up, there seems to be little doubt that at least two species exist in the Wenlock rocks of N. S. Wales—one represented by Figs. 1, 2, 4, and 5, and a second by Fig. 3. To the former I conceive belong the cancellated plates Figs. 4 and 5, and for these, including the series of plates composing the somewhat disunited sac-like body, is suggested the name of *Turrilepas Mitchelli*, mihi.

The remaining plate, Fig. 3, will for the present remain as *Turrilepas*, sp.

[1] Geol. Mag. 1865.
[2] Mon. Sil. Foss. Girvan, 1880, fasc. 2, p. 214, t. 14. f. 22–24.
[3] Woodward, Q.J.G.S. 1865, vol. xxi. t. 14; Geol. Mag. 1865, p. 470.
[4] Syst. Sil. Bohême, 1872, i. Suppl.

Jaws of Annelids. Pl. XI. Figs. 6–10.

Originally described by Dr. Pander in 1856 in connection with the fish remains of the Russian Baltic Silurian, these bodies have now been satisfactorily shown by Dr. G. J. Hinde to be the horny jaws of Errant Annelids. Their intermediate history has been so fully treated by this author in his papers mentioned below,[1] that it is quite unnecessary to enter into the subject. It is now sufficient to state that these little bodies have been found in strata ranging from the Cambro-Silurian to the Carboniferous, and it is stated by Dr. Hinde that they "occur as small dark shining objects, very varied in form, dispersed through the rock, quite detached from each other, and from the positions they occupied in the head of the animal. . . . . Except in cases where they have been long exposed to weathering influences, the jaws are of a bright glossy black tint."

Dr. Hinde further adds that the size of the jaws varies between $\frac{1}{12}$ and $\frac{1}{3}$ of an inch in length; that their resemblance to the masticatory organs of recent Annelids is very striking; and that so far as his researches have extended, three families are represented in Palæozoic rocks—the Eunicea, Lycoridea, and Glycerea—the first containing the largest number of forms.

In the case of the Australian jaws precisely the same general description applies. Three forms of jaws have so far been obtained by Mr. Mitchell, with a number of other indeterminable fragments.

Form 1.—A jaw plate (Figs. 6, 7, and 10) composed of a horizontal ramus, terminating anteriorly in a little curved short hook, blunt, and possessing a general average length of two mm. There are no perceptible denticles, so far as observation has gone, whilst the posterior end is excavated into a V-shaped notch. This so manifestly recalls some of the non-dentate species of *Eunicites* figured by Hinde, that I include it in this genus as *E. Mitchelli*. It does not closely approach any of the species given by this author in its more minute detail, nor does it exhibit the same curvature or conical section of the bodies figured as the pincers of *Eunicites* from Gotland,[2] although this may be only the result of pressure perhaps.

Form 2.—The jaw-plate in this variety (Fig. 8) is much elongated, the upper and lower margins sigmoidally curved, terminating forwards in a rather long attenuated hook, which is inclined to the ramus at first nearly at right angles, and almost in the same plane. The superior margin is occupied by a series of small denticles, greatly disproportionate in size to the anterior hook, about eight to ten in number, and apparently placed on a flattened border. Immediately below the denticulate margin is the most prominent and convex portion of the plate, followed below by a concavity, extending along the central part of the plate. This form (Fig. 8) seems

[1] On Annelid Jaws from the Cambro-Silurian, Silurian, and Devonian Formations in Canada, and from the Lower Carboniferous in Scotland, Q.J.G.S. 1879, vol. xxxv. p. 370, t. 18–20.

On Annelid Remains from the Silurian Strata of the Island of Gotland, K. Svenska Vet.-Akad. Handlingar, 1882, vii. No. 5.

[2] K. Svenska Vet.-Akad. Handlingar, 1882, vii. no. 5, t. 1, f. 1–5 (*separate copy*).

to approach nearest to *Arabellites hamatus*, Hinde,[1] or even *A. cornutus*, Hinde,[2] and I propose to call it *Arabellites bowningensis*.

Form 3.—A jaw-plate with numerous teeth along the superior margin, and a simple, short, blunt hook at the anterior end, hardly elevated above, or larger than those which succeed it behind. The denticles are eight to ten decreasing in size backwards, sharp, pointed and rather recurved. The upper and lower margins are sub-parallel, and the plate expanding slightly towards the front, whilst the posterior end is rounded. The lower margin has a small appendage projecting below the anterior part of the basal line.

I take this (Fig. 9) to be a species of *Œnonites*, and to be near *Œ. parvulus*, Hinde.[3] It is proposed to call the species *Œnonites hebes*.

It is hoped that these brief and imperfect notes will be sufficient to call the attention of collectors in New South Wales to these peculiar and interesting little bodies. The Bowning beds are doubtless not the only portion of the Australian Palæozoic series in which they occur, and the writer would suggest rigid search being made for their remains in the Upper Silurian rocks so largely developed around Melbourne, in Victoria, amongst other places.

Localities.—Eunicites Mitchelli, *Arabellites bowningensis* and *Œnonites hebes* are all from the Lower Trilobite bed of Bowning Creek; but the first named has also been found by Mr. Mitchell at Silverdale, near Bowning.

EXPLANATION OF PLATE XI.

[size].

Fig. 1. A group of plates of *Turrilepas Mitchelli*, R. Eth., jun. (about twice nat.
Figs. 2, 4, and 5. Three separate plates of same species much enlarged.
Fig. 3. *Turrilepas*, sp., also much enlarged.
All from the Wenlock Limestone, New South Wales.
Figs. 6–10. Jaws of Annelides (much enlarged).
Figs. 6, 7, and 10. *Eunicites Mitchelli*, R. Eth., jun.
Fig. 8. *Arabellites bowningensis*, R. Eth., jun.
Fig. 9. *Œnonites hebes*. R. Eth., jun.
All from the Lower Trilobite bed of Bowning Creek, New South Wales, etc.

II.—Note on the Occurrence of Trigonograptus ensiformis, Hall, sp., and of a Variety of Didymograptus v-fractus, Salter, in the Skiddaw Slates.

By H. Oliphant Nicholson, Esq.

I WISH to take the opportunity of recording the occurrence of the above-named Graptolites in the Skiddaw Slates of the Lake District, as they seem of exceptional interest.

I. Trigonograptus ensiformis, Hall, sp. Figs. 1–2.

The first of these closely resembles, and is probably identical with, the species described and figured by Hall from the Quebec Group under the name of *Retiolites ensiformis*, Hall.[4] Professor Lapworth, however, in 1875, for several reasons, transferred Hall's *Retiolites ensiformis* to the genus *Trigonograptus*,[5] a transference

[1] Q.J.G.S. vol. xxxv. p. 377, pl. xviii. fig. 12, 1879.
[2] *Ibid*, p. 377, pl. xviii. figs. 13, 14, 15.
[3] K. Svenska Vet.-Akad. Handl. 1882, t. 1.
[4] Grapt. Queb. Group, p. 114, pl. xiv. figs. 1–5.
[5] Quart. Journ. Geol. Soc. Nov. 1875, p. 659, pl. xxxiv. figs. 8*a*–8*c*.

which had been previously suggested by my father, so that the species now stands as *Trigonograptus ensiformis*, Hall, sp.

The characters of my specimen of *Trigonograptus ensiformis*, Hall, sp., as far as it is possible to make them out, are as follows. It is the upper half of a sublanceolate diprionidian polypary, about 1½ centimetres in length. There is marked convergence of the margins towards the distal extremity, but the actual tip is not seen. At its widest part it measures about 3 millimetres, and its total length if completed would be about 3 centimetres, if we suppose the margins to converge similarly towards the base, as is shown in the entire specimens figured by Hall. Running up the centre of the polypary is a remarkably well-defined and absolutely straight axial line, and given off from this in alternate fashion are the equally well-defined hydrothecal partitions. Measured vertically there are about ten hydrothecæ to the centimetre. No signs of reticulation are visible.

The specimen which I have thus shortly described was obtained in the Upper Skiddaw Slates (Ellergill Beds), from a small exposure in one of the feeders of Mosedale Beck, near Troutbeck, Cumberland. It is in good preservation, and the characters included in the description are readily determined. From its very peculiar subfusiform shape alone, if for no other character, I think one may safely consider it to be identical with Hall's Quebec form, which Professor Lapworth has now wisely removed from the genus *Retiolites*. The present Graptolite is clearly not referable to that genus, as no trace of punctation or reticulation can be detected, but this is likewise a doubtful feature in Hall's specimens, as he himself hints at the possibility of separating the species as the type of a new genus.

Fig. 1.—The specimen of *T. ensiformis*, Hall, sp., described above, of the natural size. Upper Skiddaw Slates (Ellergill Beds), Mosedale, near Troutbeck.

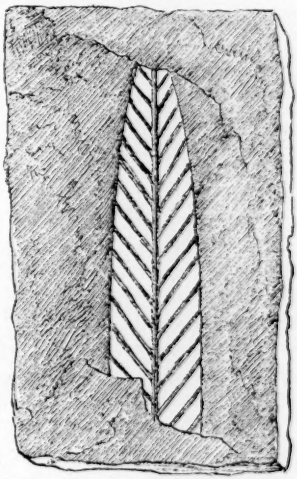


Fig. 2.—The preceding Figure enlarged about four times.

The *Trigonograptus ensiformis*, Hall, sp., described by Professor Lapworth from the Lower Arenig formation, Ramsey Island,

resembles my Skiddaw Slate specimen in many respects.[1] If not the same species, it is a very closely allied form, the chief difference being its smaller size. Professor Lapworth also describes another species from the same locality under the name of *Trigonograptus truncatus*,[2] which in many points resembles my specimen, but it cannot be identical with it, as in all the Ramsey Island specimens the polypary is abruptly terminated by a straight line at its distal extremity, while in the present specimen the margins are seen to converge towards the distal end, and clearly meet at a point. Lastly, I cannot identify my specimen with *Trigonograptus lanceolatus*, Nich.[3] The shape of the polypary in that species, owing to the fact that the margins so rapidly diverge distally, is alone sufficient to separate it as a distinct species.

II. Didymograptus v-fractus, Salter, var. volucer. Fig. 3.

The other Graptolite to be described may be provisionally referred to *Didymograptus* v-*fractus*, Salter, of which it appears to be, at least, a well-marked variety. It was obtained from the Skiddaw Slates at Outerside, near Keswick, and is fairly well preserved.

The two branches of the polypary in the specimen in question (Fig. 3) are very distinct. They increase very gradually in width from their point of origin, and attain a maximum breadth of three millimetres.

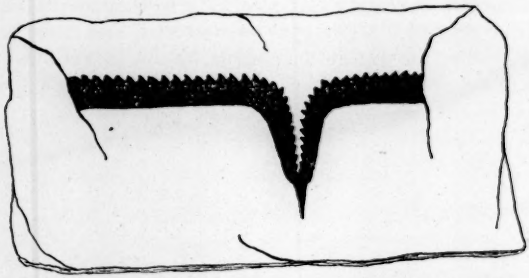


Fig. 3.—*Didymograptus* v-*fractus*, Salter, var. *volucer*, of the natural size. Skiddaw Slates, Outerside, near Keswick.

The sicula in this specimen is not quite complete, but seems to taper gradually to a point. From the summit of the sicula the two branches of the polypary diverge, forming a basal angle of 10°, and at a distance of 9 millimetres from their origin each branch is bent abruptly at right angles to the sicula, so as to form a straight line. The denticles, which at some parts of the polypary are well defined, are slightly mucronate, and there are about 15 to the centimetre.

It will be seen from the above description that the essentially characteristic point in this specimen is the general form of the polypary. The original specimen of *Didymograptus* v-*fractus* was figured by Mr. Salter in a note on the Graptolites of the Skiddaw

[1] *Loc. cit.* supra.
[2] *Loc. cit.* p. 660, pl. xxxiv. figs. 9*a*–9*d*.
[3] Ann. and Mag. N. Hist. 1869. ser. 4, vol. iv. p. 232, pl. xi. fig. 6.

Slates,[1] but this figure was not accompanied by any description, and, so far as I am aware, no description has been published by any subsequent writer.

Nevertheless, the form of the polypary in this species is so characteristic, as will be seen from the subjoined figure (Fig. 4), that the species has been accepted as valid by Professor Lapworth in his classical paper on the geological distribution of the Rhabdophora,[2] as also by Herrmann, Tullberg, and others.

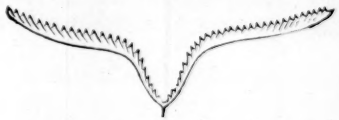


Fig. 4.—*Didymograptus* v-*fractus*, Salter. Natural size. Ordovician (Skiddaw Slates).

In the original *Didymograptus* v-*fractus*, Salter, the basal angle of the two branches of the polypary is considerably more open than in the specimen here under consideration, and the curvature of the branches is effected in a gradual upward sweep. On the other hand, in my specimen, the basal portions of the branches diverge very slightly, and then are reflected abruptly, at right angles to a line traversing the axis of the sicula.

The distinction just pointed out is so marked, that Professor Lapworth, to whom I submitted the specimen, suggested, that though it might be placed under *Didymograptus* v-*fractus*, it would be well to distinguish it by a varietal name; and following his advice I have named the form *Didymograptus* v-*fractus*, Salter, var. *volucer*. It is by no means impossible that future discoveries may serve to raise this to the rank of a distinct species.

With the exception of the doubtful form recorded by Baily from the Lower Bala rocks of Ireland, under the name of *Didymograptus Hisingeri*,[3] all the species of the group *Didymograptus* v-*fractus* are found in the Arenig Beds. Two species belonging to this group have been described by Tullberg,[4] from the Arenig Beds of Sweden, under the names of *Didymograptus balticus*, and *Didymograptus vacillans*, but it is quite unnecessary to discuss the characters of these, as they show no marked resemblance to the specimen now in question. Salter, in the paper above quoted, refers to a Graptolite recorded by McCoy from the Ordovician rocks of Victoria, under the name of *Didymograptus Pantonii*, and states that this shows a considerable similarity to his *Didymograptus* v-*fractus*. McCoy's form, at the time when Salter wrote, had neither been described nor figured, but the resemblance suggested by him was accepted by subsequent writers. Hence Mr. R. Etheridge, jun., in 1874, described and figured a *Didymograptus* from the Ordovician rocks of

[1] Quart. Journ. Geol. Soc. vol. xix. p. 140, fig. 13*e*.
[2] Ann. and Mag. N. Hist. ser. 5, vol. iii.
[3] I regret that I am unable to find a reference for this.
[4] Geol. För. Förh. No. 58, Bd. v. No. 2, p. 39, 1880.

Victoria, under the provisional title of *Didymograptus Pantonii*, McCoy.[1]

McCoy, however, in the same year, but apparently at a later date, described the form in question as a species of *Tetragraptus*, Salter, and as probably identical with *Tetragraptus fruticosus*, Hall.[2] This view of the affinities of *Didymograptus Pantonii*, McCoy, was later accepted by Mr. Etheridge.[3] At the same time it is possible, that *one* of the two forms placed by Mr. Etheridge, in his original paper in the "*Annals*" (*loc. cit.* pl. iii. fig. 21), is really a species of *Didymograptus*, and perhaps may be identical with my *Didymograptus v-fractus*, Salter, var. *volucer*. Owing, however, to the fact, that the figure just alluded to only shows a part of the basal portion of the polypary, it is not possible to make this assertion with any confidence.

The only other form which may be alluded to is that named by Baily *Didymograptus Hisingeri*, from the Lower Bala rocks of Ireland, which has been included by Herrmann in the group of *Didymograptus v-fractus*, Salter.[4] I am not aware, however, that this form has been either described or figured, and I am therefore unable to offer any opinion as to its real affinity. In conclusion, I wish to express my great indebtedness to Professor Lapworth, F.R.S., for his most friendly assistance and advice in the preparation of this notice.

III.—Secular Straining of the Earth in Relation to the deep Phenomena of Volcanic Action.

By T. Mellard Reade, C.E., F.G.S., etc.

THE application by Dr. Johnston-Lavis of the theory of the secular straining of the Earth, with which my name and Mr. Davison's is connected, to an explanation of the deeper phenomena of volcanic action, is ingenious and suggestive.[5] It will, therefore, I trust, be of some use if I am allowed to discuss and criticize the principles and propositions that appear to me to be necessarily involved in the views put forth by Dr. Johnston-Lavis. Before doing this, I feel it incumbent upon me to point out that Mr. O. Fisher's position with regard to the question seems to have been misunderstood. So far from occupying an antagonistic position, he has done much to mathematically develop the theory; and it is only when we come to its practical application to the explanation of geological phenomena, that he, myself and Mr. Davison differ.

In the "Origin of Mountain Ranges," and elsewhere, I have expressed the opinion that it is "a weak point in most theories of volcanic action that the machinery invoked is insufficient to bring up molten matter from a great depth." I agree with Dr. Johnston-Lavis that the continuous outflow of lava, which has taken place since the dawn of geological history, demands a supply of heat drawn

[1] Ann. and Mag. Nat. Hist. 1874, vol. xiv. series iv. p. 7, pl. iii. figs. 21-22.
[2] Geol. Survey, Vict. 1874, dec. i. p. 13, pl. i. figs. 9–14.
[3] A Catalogue of Australian Fossils, by R. Etheridge, jun., F.G.S., 1878.
[4] Die Graptolithenfamilie Dichograptidæ, Otto Herrmann, 1885.
[5] Geol. Mag. June, 1890.

from a central source. I have also in the work referred to indicated how this supply of lava may, through local variations of temperature induced by sedimentation, be pumped up to the surface, there to undergo the modifications exhibited in ordinary volcanic phenomena.

The explanations therein attempted of deep volcanic phenomena do not, however, exclude the co-existence of a secular and wider cause, such as that formulated by Dr. Johnston-Lavis.

I have very little faith in the efficacy of tangential compression, induced by secular cooling, as a mountain-building agent, as the shell-of-compression is too thin to produce results of the magnitude we see in nature.

The shell-of-contraction is, as I have shown,[1] vastly greater than the shell-of-compression, and under certain conditions might be a very efficient machine for the forcing up of lava to the surface. It is these necessary conditions that I propose to discuss, and to inquire whether there is a probability of their existence.

Firstly, then, we must ascertain under what conditions the secular contraction takes place. The shell-of-compression is, according to the highest estimate, not more than five miles thick, and according to Mr. Fisher is under two miles.

Below the under-surface of this shell the whole of the crust of the earth, to a depth at which cooling ceases, is in a state of contraction. This shell of contraction, for the proper conception of what takes place, may be divided into an infinite number of shells, each of which contracts at a different rate, the shell of greatest contraction being situated at a maximum depth of 54 miles according to Fisher.[2]

It will thus be seen that it is not a simple case of contraction, like that of the tire of a wheel or the hooping of a gun, but an infinite compound series of tires all contracting at different rates. Assuming that the shells are homogeneous and free from fractures, it would be very difficult to say what the effective contractile force of this compound would amount to, even if we knew the tensile strength of the materials composing it, which we do not.

It could not contract as a whole without internal movements in itself partially destroying its effectiveness for compressing the nucleus. The problem is still further complicated by the compressive-extension produced by the gravitation of the overlying shell of compression as well as of the various shells or matter constituting itself. The idea may be best realized by stretching an elastic band on a plane surface and then weighting it; the weighting will interfere with the contractile force the band would otherwise develop, and if sufficient destroy its movement. I have shown that at the zone of greatest contraction "practically tension could not take place, as the superincumbent strata would by vertical compression elongate the rocks at the zone of greatest contraction to fill the vacuities that otherwise would be created."[3] At what depth compressive-extension would take the place of tensile stress I am not prepared to

[1] Origin of Mountain Ranges, chap. xi.
[2] Physics of the Earth's Crust, second edition, p. 106.
[3] Origin of Mountain Ranges, p. 125.

say, as the molecular condition of the materials of the earth's crust will be modified by the pressure tending to produce compressive-extension.

In addition to this natural difficulty arising from the conditions being outside any laboratory experiments so far made, is also one arising from our ignorance of the nature and extent of the continuity of strata at great depths. At the surface the rocks are divided by faults and fractures, which must interefere very much with their action as an effective contracting and compressing envelope to the earth's nucleus.

I have now indicated some of the principal dynamical conditions of the problem which it will be necessary to have answered more clearly before we can arrive at anything more than uncertain conclusions as to the effect of the contracting shell on the earth's nucleus, and I have avoided any appeal to geological phenomena either for or against what may be provisionally designated "the contracting shell theory" of deep volcanic action. It would seem that *some* compression must be set up in the nucleus by secular contraction, which if not an effective cause in itself of the expulsion of lava, it may be in conjunction with local thermal effects such as I have indicated in chap. xxi. of the "Origin of Mountain Ranges." I do not think it theoretically necessary that there should be actual rifts in the shells at the depths at which release of pressure will allow the earth's magma to change from the solid to the fluid state. Lava if under constant pressure would force or bore its way through any strata exhibiting local weakness without a rift occurring. Indeed, as I have already explained, no rift could occur at great depths, because of the compression produced by gravitation or otherwise compressive-extension. As I have elsewhere attempted to show, the rifts connected with volcanoes must be comparatively speaking surface phenomena, and the "feeders" or communications of the volcanoes with the central reservoir must be necks or pipes, not fractures.

So much for the earth. If we on the other hand turn to the moon, we find the ring-mountains and other volcanic phenomena studding its surface more readily explicable by the contracting shell theory. As gravity on the moon's surface is only about one-sixth that on the earth's, it is quite likely, as I have already suggested, that the pressure was insufficient to produce solidification of the moon's nucleus, which would therefore be a fluid mass inclosed in a gradually thickening solid shell.[1] If so, we have all the conditions present for effective contraction and expulsion of the fluid magma at the surface, for the shell would probably have a greater coefficient of tensile strength than that of the earth, and its greater thickness proportionally to the moon's diameter would make it a stronger compressing vessel, while the work it had to do, from the smaller size of the nucleus, its fluid condition and low specific gravity, would be much less than in the case of a planet of the magnitude and

[1] See note by me appended to the paper by the Rev. F. Grensted entitled "Theory of the Airless and Waterless Condition of the Moon," Proceedings of the Liverpool Geol. Soc. Session 1887-8.

solidity of our earth. Hence, it is not surprising that there should be signs of that vast welling out of lava we see so plainly on the surface of the moon in the form of rings 50 miles in diameter and 10,000 feet high. The moon therefore seems to afford an example of volcanic action minus water—a phenomenon it was at one time supposed could not exist.

IV.—Vulcano and Stromboli.[1]

By L. W. Fulcher, B.Sc.,
of the South Kensington Museum (Science Branch).

SINCE the excellent and interesting series of papers on the history and description of these celebrated volcanoes by Professor Judd, which appeared in the Geological Magazine for 1875, there is, as far as I know, no connected record of their condition. The islands, though affording such excellent opportunities for the study of volcanic action, are but rarely visited by geologists; but having had the opportunity of examining them myself in the autumn of last year as a member of the party arranged by Dr. Johnston-Lavis under the auspices of the Geologists' Association, I thought it would be well, whilst recording my own observations, to prefix a brief account of the volcanoes since the above-mentioned date. The information, on which the following brief sketch is based, has been derived partly from a series of papers by Prof. Mercalli,[1] on notes derived by correspondence with Sig. Pincone, the former manager of the lately existing Chemical Works at Vulcano, who now resides at Lipari, and partly from papers in various periodicals to which I will refer as occasion requires.

I.—Vulcano.

After having been in almost complete repose for nearly a century, Vulcano resumed its activity in September, 1873, and has not since returned to its former tranquillity. When Prof. Judd visited it in April, 1874, the crater was over 400 feet deep, with a floor whose diameter was about 200 yards. The crater walls rose vertically at the bottom, but afterwards sloped outwards at an angle of about 45°, so that the diameter of the crater rim was about 600 yards. The crater floor was much encroached upon by a talus of materials shaken down from the adjoining crater wall, and especially by a series of irregular cones of fragmentary materials around the orifices of ejection on the northern side. There were four mouths still open, from which considerable quantities of vapour escaped. All over the sides and bottom of the crater fumaroles, some of very large proportions, were discharging acid vapours and gases. Around their orifices were deposits of white, yellow and red incrustations. Halfway down, on the slope of the cone, was a little crater—the Fossa Anticcha—whose floor was about 60 yards in diameter. To the west of this crater, on the north-west side of the cone, was an obsidian lava flow.

In 1873 the crater had been purchased by an English company

[1] Atti Soc. Ital. Sci. Nat. Milan. vols. 22, 24, 27, 29 and 31.

for the purpose of collecting the chemical products, boracic acid, sal-ammoniac, sulphur and alum, which the volcano affords in large quantities and at the time of Prof. Judd's visit there was a well-made road proceeding by zig-zags up the side of the cone, and descending into the crater by means of a viaduct, to facilitate the conveyance of the products of the "fabbrica" near Faraglione. Here the products were roughly separated and forwarded to England for purification.

The cone presented a similar appearance to Prof. Mercalli, who visited it four years later, in 1878, except that another orifice about 12 feet in diameter existed in the east side of the crater floor. It did not then exhale any vapour. It was produced by a slight eruption in 1875. Prof. Mercalli also noticed subterranean rumblings, which were especially audible on the north side. From 1873 to 1879 Vulcano continued in activity, at least one eruption occurring in each year. The ejected material were ashes and lapilli, which in the eruption of July, 1876, were carried by the wind as far as Lipari and Salina. No lava has been emitted in any of the eruptions from 1873 up to the present time. Indeed, the last lava flow was that obsidian stream mentioned above as existing on the north-west of the crater, which is usually assigned, on the testimony of Dolomieu, to the year 1775, but on the authority of Trovatini, a Liparote monk, who in the early part of the present century (1810) described a violent eruption of this crater as having taken place in February, 1771, inclines Prof. Mercalli to this latter year as more probable.

The gases evolved by the fumaroles were often ignited, the flames being tinged with various colours, according to the nature of the minerals (arsenic, sulphur, or boracic acid) which were predominant in their exhalations. In one case, the eruption of 1873, one of the fumaroles burnt with a pale flame which has been attributed to pure hydrogen, but although hydrogen has been detected among the gaseous emanations of this volcano, one cannot help thinking that it was more probably due to sulphuretted hydrogen.

In January, 1880, Mr. Rodwell ascended the cone. Steam was issuing at high pressure from various orifices. On the south-west side of the crater floor was a large opening, from which exceedingly hot air arose. Hot sand and green and blue flames were occasionally emitted, while loud rumblings proceeded from it as if much agitated lava existed below, but no lava could be seen. For the five years 1880–1885 Vulcano seems to have been comparatively tranquil, only emitting dense volumes of "smoke" at times. But in January, 1886, it broke out again with great violence. On the 10th January it ejected scoriæ and ashes, and the eruptions continued with moderate energy till they culminated in a tremendous explosion on the 26th.[1] Incandescent material, scoriæ and ashes, some of the ejectamenta being of very large size, were shot out in abundance with a terrific uproar. The chemical works were destroyed, and many of the workmen in fear abandoned the island and took refuge at Lipari. A small internal cone was in the crater, but after a while disappeared.

[1] Nature, vol. xxi. p. 400.

In May, 1887, Dr. Johnston-Lavis visited Vulcano, accompanied by Sig. Platania.[1] They found that the eruption of 1886 had drilled out the crater so that they were unable to descend into it. The floor of the crater was covered by a layer of purplish-grey ash washed down from the sloping sides, and the fissures in it were blowing off steam in great quantity. The edges of the fissures on the bottom and lower part of the sides were covered by a yellow crust of sulphur, boracic acid, etc.

It presented the same appearance to Prof. Blake, who, however, about the time was enabled to enter the crater by a well-made path.[2]

A very violent eruption occurred in August, 1888. Mr. Narlian wrote an exceedingly graphic description of the phenomena in a letter to Dr. Johnston-Lavis.[3] which has been considered worthy to stand side by side with Pliny the Younger's description of the Vesuvian eruption of A.D. 79. An outburst occurred from the crater on the 3rd of August, and after lasting about a quarter of an hour, ended. This was followed by rushes of thick black smoke at intervals of 20 to 30 minutes, but towards the evening these also ceased. As night approached, the fumaroles on the side of the cone were very active, and began to show flames. Towards morning a tremendous explosion took place, and large incandescent boulders were shot out to a considerable distance, while a burning rain of ashes, lapilli, and stones set light to the trees and vineyards situated around the base of the cone. Mr. Narlian's house was laid in ruins: a huge boulder falling on the roof crashed its way right through the house. A boulder, not less than ten yards in diameter, was ejected nearly three-quarters of a mile from the crater, and buried itself some 10 or 11 feet in the ground. The volcano became quiet on the 6th of August, and remained so for 13 days; but on the 18th the eruptions recommenced with loud detonations.

In a later letter of Mr. Narlian's to Dr. Johnston-Lavis,[4] it is stated that the eruptions were still going on in November, and a change in the character of the ejectamenta was noted. At first, stones were being ejected, but afterwards pumice of a dark rough kind. It is worthy of notice that during this eruption Stromboli did not exhibit the slightest increased activity.

Shortly afterwards the volcano was visited by Signor Giovanni Platania, together with Prof. Silvestri and other gentlemen.[5] The crater did not occupy the central part of the cone, but opened more to the west, and its internal walls showed several beds of altered materials of old eruptions. It was deeper than in 1887. The bottom was formed of enormous blocks of old altered lavas and furrowed by large fissures which were blowing off steam very actively. The coloured sublimations which covered the bottom and walls of the crater in 1887 had disappeared. Eruptions occurred with a loud noise at intervals of a few seconds. A grey "smoke" arose from the bottom of the crater, consisting of ashes accompanied

[1] Nature, vol. xxxviii. pp. 13, 14.
[2] Proc. Geol. Assoc. vol. xi p. 176.
[3] Brit. Assoc. Report, 1888, pp. 665–6.
[4] Nature, vol. xxxix. p. 111.
[5] La Nature, 1888, 2e sem. pp. 198 and 359.

by large blocks which fell back into the crater. Sig. Platania also thought he could detect a certain correspondence of the stronger eruptions with barometric minima.

Prof. Silvestri considers that the phenomena of the eruption described above characterize a special phase of activity which he has also observed at Etna, and to which he proposes to apply the title of *Vulcanian phase*,[1] corresponding to the terms already in use, viz. *Plinian* phase for that of greatest activity accompanied by seismic paroxysms, and *Strombolian phase* for that of moderate activity. The Vulcanian phase is then characterized (1) by intermittent eruptions of enormous masses of vapour, carrying up with it ashes and lapilli and the ejection of fragments of ancient lavas, as well as bombs of fresh lava; (2) by the tranquillity of the ground—only one very slight tremor having been felt before the eruption just described; (3) by the want of lava streams, although the presence of fused material at great depth is attested by the production of bombs.

In September, 1889, I formed one of the party conducted by Dr. Johnston-Lavis to the Lipari Islands. We visited Vulcano on the 21st September, and again on the 23rd. After inspecting the ruins of Mr. Narlian's house and the Chemical Works, we ascended the cone. The crater presented a very different appearance to that which it did before the last eruption. It was almost completely filled up with fragmentary material, being not much more than 50 feet deep below its lowest edge, as judged by the eye. Its diameter was about 600 feet. The surface was covered with brown ash, and strewn with small blocks of ejected bombs. At varying intervals of 20 minutes or so, without any warning and with a rushing sound, inaudible at any distance away, an immense column of fine dust and small pieces of scoriæ rose in the air to a vast height. The scoriæ quickly fell back on the crater rim with a noise like hail, while the dust rose, carried up by the immense quantities of vapour, to several times the height of the cone. Since the cone is about 1000 feet above sea-level, the dust column must have been some thousands of feet in height. Standing on the windward side of the crater, we were able to watch many of these eruptions, but they all presented the same phenomena. One eruption, however, that we witnessed after nightfall on the first day (September 18) of our arrival at Lipari, was of a more violent character. The dust column broke out with a ruddy glow at the base, and some large blocks were shot out on to the sides of the cone, while a bright flash of lightning lit up the scene.

The Fossa Anticcha has now disappeared, being filled up with the fragmentary material which covers the sides and district around the cone to some depth. About the spot where it existed are several fumaroles, from one of which we secured some of the brilliant red (realgar), yellow (sulphur) and white (alum, etc.) sublimations, with which its orifice was surrounded.

Around the base of the cone, and especially on the level ground by Mr. Narlian's house, were scattered large quantities of volcanic

[1] Comptes Rendus, tom. cix. (1889) p. 241.

bombs, with the "bread crust structure," which have been described by Dr. Johnston-Lavis.[1] Here and there we came across a series of slight depressions in the ground, where a bomb had rebounded, and which the wind had not yet had time to fill up with volcanic dust to the level of the surrounding surface. In other places the bombs had broken into a multitude of fragments, or had partially buried themselves in the dust. Some of the bombs contained in the outer coating of obsidian, which surrounds their pumiceous interior, pieces of lava (augite andesite) which had been caught up in them, and also some remarkable inclusions of a milky white substance, which, when collected, were supposed to be quartz. They possessed somewhat the appearance of a sandstone in which the grains of quartz had fused into one another, but a section cut from a specimen reveals a very different tale. With the exception of various small areas of quartz, with small liquid inclosures, it consists of a vesicular isotropic glass, which contains here and there fragments of a felspar much kaolinized, the edges of which fade gradually into the surrounding glass. Mr. G. A. J. Cole, who has very kindly examined the section which I had prepared for me, is inclined to the opinion that it is the result of the fusion of some kind of granitoid rock.

The obsidian, in which it is inclosed, contains in its glassy basis crystals of sanidine and augite, which is very strongly pleochroic, the colour changing from yellow-brown to green. Hence the augite probably contains a large per-centage of soda. There are also numerous small round crystals too small for determination under the microscope only. I understand, however, that Dr. Johnston-Lavis is engaged in an examination of the ejectamenta.

In a short sketch, published in the Scottish Geographical Magazine for March, 1890 (of the visit of our party to the Italian volcanoes), Dr. Johnston-Lavis adduces some interesting evidence from the rupture of the telegraphic cable between Lipari and Sicily of a probable submarine eruption near the island of Vulcano.

Again, a letter from Dr. Johnston-Lavis in "Nature," for May 22, 1890, announces a new eruption of Vulcano on March 15, when a loud explosion occurred. Some windows were broken at Lipari (six miles distant) and a rain of lapilli and condensed vapour fell upon the town. The eruptions lasted with diminishing activity till the 17th, when they ceased. The crater is somewhat deeper than in September, 1889, and some new fumaroles have appeared inside its walls.

II.—Stromboli.

This volcano, on account of its greater inaccessibility, is much less visited than Vulcano, and the records of its condition from time to time are very scanty. Starting from the same point as in the case of Vulcano, namely, Prof. Judd's visit in April, 1874, we find that the thick clouds of vapour prevented an observation of what was taking place at the bottom of the crater. The eruptions succeeded one another at intervals of from two to ten minutes, and consisted of

[1] Nature, vol. xxxix. p. 109.

violent outbursts of steam, carrying aloft fragments of lava, scoriæ and ashes. Prof. Judd thought that there were at least two orifices in the crater discharging independently. On the north side of the crater he observed a fissure encrusted with yellow salts.

Two months later, in June, there appears to have been somewhat greater activity, the volcano ejecting blocks into the inhabited district of the island, which is situated at a distance of about two miles from the crater. I cannot find any records of the state of the volcano for the next four years; but on 4th Feb. 1879, an eruption occurred with a loud detonation which was heard to the south of Vulcano, a distance of 45 kilometres (28 miles). Volumes of "smoke" arose from the crater, while the surface of the sea was covered for some distance with floating pumice. In June of the same year there was also a slight outburst. Mr. Rodwell visited Stromboli in 1880, and states that it was giving off enormous quantities of steam, but the ejection of red-hot scoriæ only occurred at long intervals. The volcano remained in a tranquil state till 1882, when a very important eruption took place.

After several minor outbursts in the months of January, March and April, the activity culminated in November. On the 17th of this month at 10·30 p.m. a loud detonation was heard, and scoriæ and ashes, together with steam, were ejected in great abundance for a few minutes and then ceased. A subsultory earthquake shock was felt, indicating internal disturbances, and some hours later the mountain was lighted up by an immense quantity of incandescent material which was thrown to a considerable height. Simultaneously another earthquake shock was perceived, and a detonation, "as if 1000 cannons had exploded at once," caused great consternation among the inhabitants. No one at Stromboli had ever heard such an explosion. It was caused by the opening of five lateral mouths on the slope of the Sciarra about 100 metres below the ordinary crater. These discharged incandescent material and ashes with greater violence than the central crater had ever shown. The eruptions continued with more or less violence till December, when the lateral mouths closed, and the central crater resumed its ordinary activity. No lava issued during the eruption, and Vulcano remained perfectly tranquil. Prof. Mercalli thinks that this eruption is probably the most violent which has happened during the recorded history of Stromboli, a period of some 2000 years. The inhabitants had never seen their volcano in such activity, and even thought of abandoning the island. Another very remarkable feature of this eruption is that the ejectamenta issued from lateral mouths. Never before has a lateral eruption been recorded at Stromboli.

In February, 1883, we gather from the notes supplied by Signor A. Pincone to Prof. Mercalli that Stromboli again broke out and covered the surface of the sea for more than a mile from the island with a reddish dust. Again, in March, a detonation was heard and the sea covered with pumice. On the 3rd July great quantities of ash were ejected, and the volcano subsided into a more tranquil state than usual, which continued for the next few years.

In June, 1887, Dr. Johnston-Lavis and Signor Platania visited the crater. They state that it was very quiet, only throwing out a very few fragments of pasty lava cake at long intervals. In fact, only four or five explosions were witnessed by them in a four hours' stay at the summit. So slight were the ejections that they were even able to land on the beach at the foot of the Sciarra. Five months later, however, the activity increased, since on November 17th the sea was covered with pumice. It was in a state of repose in August, 1888, according to Signor Giovanni Platania.

The 19th September was set apart for our examination of Stromboli during our stay at Lipari. We ascended the cone from the north side. In the crater, when the wind carried off some of the vapour, we could make out five mouths, from one or other of which an eruption occurred at intervals of a few minutes. The eruption began with a dull report, accompanied by volumes of steam, whilst a multitude of pieces of red-hot lava were shot into the air to a height of two or three hundred feet and fell back partly into the crater and partly around the sides with a sharp rattling sound. The scoria lumps which happened to fall on the slope of the Sciarra rolled in a cascade towards the sea, but few of the pieces reached it. Now and then, between the eruptions, a curious ring of white vapour would arise from one of the mouths, and gradually ascend in the air, revolving and twisting, but preserving the form of a ring for a considerable time. After watching the action going on below from the summit, we descended along the western arm of the ridge and reached a spot where we could watch the eruptions nearly on a level with the erupting vents. Here quantities of light lapilli fell on and around us after every explosion. Continuing our way along the precipice, we were able to obtain a view of the crater from the front, that is, the seaward side, where the same phenomena presented themselves. Just below one of the mouths, and for a short distance down the Sciarra, a piece of lava would now and then break off and roll towards the sea, exposing a red-hot surface beneath. The effect of the eruptions was very fine at night. We did not observe any coloured incrustations in the crater nor were we able to see the lava rising and falling in the tube as described by Spallanzani and others.

Signor Platania, who accompanied our party, has written a description[1] of the state in which we found both this volcano and Vulcano, and compared it with the appearance it presented on his former visit.

Such, then, is a brief description of the phenomena presented by these volcanoes since 1874. The record is indeed very scanty, and there is great need of the systematic observation and examination of the materials ejected. Of late years, however, there seem to be more workers in the field, and I believe an observatory at Lipari is in contemplation, so that greater use will be made of the facilities which these islands afford for the study of volcanic action.

[1] Bol. Osser. Meteor. d. R. Ist. Naut. Riposto, xv. (1889).

V.—On the Base of the Sedimentary Series in England and Wales.

By the Rev. Prof. J. F. Blake, M.A., F.G.S.

(*Concluded from the July Number, p.* 315.)

3. *North-west Carnarvonshire.*—There are here two or three separate areas which, at all events historically, must be considered more or less independently, viz. the district between Bangor and Carnarvon, the Llyn Padarn and Moel Tryfaen range, and the Lleyn Peninsula. Except in reference to the last of these, it is certain that the belief in Precambrian rocks in Carnarvonshire began with Prof. Hughes. This author, indeed, quotes Prof. Sedgwick as recognizing such rocks here, but the passages he quotes have a very different meaning in the original. The slates near Bangor and Carnarvon, which Sedgwick says are amongst the oldest of North Wales, are those which occur "along the shores of the Menai Straits from Bangor to Carnarvon," which he describes as "dark earthy-coloured slates which, were we to judge only by mineral structure, might easily be confounded with Upper Silurian rocks," and these are "cut through by a great intrusive rib of syenitic porphyry of a different epoch, which ranges nearly with the beds." In the section he draws, from the Menai Straits to Glyder Fawr on the Carnarvon Chain, in an E.S.E. direction, which therefore must pass near Carnarvon, he indicates by the same letter *a* the rocks on both sides of the porphyry, and inserts no fault. From all this it is plain that what Sedgwick regarded as the very oldest rocks in North Wales are those which have since been recognized as Carboniferous shales on one side, and Arenig slates on the other! Like Prof. Sedgwick, Prof. Ramsay also taught the intrusive character of the crystalline rock, about which, at Llyn Padarn, he held a very peculiar theory. It was in 1878 that Prof. Hughes for the first time brought forward evidence in favour of the Precambrian age of the "porphyries," and of the rocks near Bangor. The principal point of his paper is that there are always conglomerates on the eastern boundary of this group, which proves that the latter are older than the conglomerates. But what is the age of these conglomerates? On this point he brings forward no evidence whatever, but merely *asserts* that the conglomerates "form everywhere the basement bed of the Cambrian." Now there are three conglomerates in question: (1) that at Twt Hill; (2) that at Llandeiniolen; (3) that on the east of Bryniau Bangor. All these three Prof. Hughes takes to be the same, and Prof. Bonney now identifies Nos. 1 and 3. My own examination of the district, however, yielded satisfactory evidence that they are all of different ages. The Twt Hill conglomerate is quite of a different character to either of the others, being far more quartzose; it is followed rapidly at that spot first by grits and then by slates, which are perfectly continuous with those carrying Arenig fossils, and the same succession may be traced on a curved line as far as Llandeiniolen, and thence along a line which runs east of and is transverse to the Bryniau Bangor conglomerate. This then is an Arenig conglomerate forming

the base of that series, and unconformable on all the beds below. The Llaneiniolen conglomerate contains a different set of pebbles, some of which correspond to the Twt Hill igneous rock, and the neighbouring felsites. It runs obliquely to the Arenig conglomerate in a N.N.W. direction, and is followed on the dip side by other conglomerates and ashy beds, with intervening compact halleflintas or slates, as demonstrated by Prof. Bonney. It is thus entirely distinct from and older than the Twt Hill conglomerate. Further north on the same dip comes the Bryniau Bangor conglomerate in the midst of similar halleflintas, and this therefore is a higher conformable bed of the same series. But though of the same series, it is not identical with the Llandeiniolen conglomerate, as is proved by the careful stratigraphy of Professor Bonney against the statement of Prof. Hughes, who acknowledges not to have examined the critical parts of the area. The Bryniau Bangor conglomerate is not, therefore, in spite of its large pebbles, the base of any series, but is due to the denudation of some new mass of felsite which has previously been covered. The only basal conglomerates as proved by stratigraphy are the Twt Hill one, which is the base of the Arenig, and the Llandeiniolen one, which is the base of some older series. These results are in absolute accordance with the mapping of the Geological Survey. All therefore we know about the group of rocks between Bangor and Carnarvon is that they are Pre-Arenig.

The Pre-Arenig rocks are considered by the Geological Survey to be altered Cambrian intruded upon by felspar porphyry. This last conclusion cannot possibly be correct seeing that the bedded portions contain fragments of the porphyries, etc., which are nowhere else to be matched in the district. The *tout ensemble* of the bedded rocks is exceedingly volcanic, being almost entirely conglomerates, agglomerates, ashes, and halleflintas. We must not assume that the Geological Survey has overlooked this fact, and has imagined that the ordinary slates and grits could change into such as these. We must read the words "altered, Cambrian" with a comma, and as intended to indicate two distinct opinions, that they must be classified with the Cambrian (though they may be lower beds than any elsewhere seen), and that they are altered. Perhaps their only direct connection with ordinary Cambrian rocks is the occurrence amongst them on the west of Bangor and elsewhere of purple slates. They are entirely cut off on the east by the overlap of the Arenig. Under these circumstances all that can be said at present is that as the Cambrians nearest on the east have no base, and these have no summit; it is *highly probable* that the two wants are satisfied together, by these being considered as basal Cambrian.

With regard to the felsites and Twt Hill rock, the fact of the Llandeiniolen conglomerate containing their fragments shows that they were in existence at the time of its formation, and must therefore antedate it, but by how long an interval will depend on their nature. It is well known that attempts have been made to prove that they are bedded; but such attempts, as in the case of St. Davids, have been entirely unsuccessful. It was Prof. Bonney

who first made the attempt in the case of Twt Hill. Admitting that he "saw nothing absolutely irreconcileable with an igneous origin," his doubts were set at rest by the observation of a conglomerate—the Arenig conglomerate—which was apparently part of the mass. These doubts should be raised again, now that the error of this observation has been made clear. There is, in fact, no sign of true bedding anywhere in the hill; there are only segregation bands of more felsitic-looking rocks, and a certain amount of brecciation in the neighbourhood of the fault. The impossibility of finding any is shown by the fact, that while Prof. Bonney states that the Twt Hill group is the highest of the metamorphic series, Prof. Hughes places it at the base, with the "Crug beds" above. It can only be theory indeed which prevents any one from recognizing the former as granitic, and the latter as granophyric, and both therefore of igneous origin. The same is the case with the Dinorwic felsites. Though called "beds" by Prof. Hughes, they are as good volcanic rocks (very possibly flows, as there are occasionally ashes with them) as any of more modern date, as has been well shown by Prof. Bonney. This being the case, they need not be separated by any long interval from the detrital rocks which contain their fragments. It may be said, perhaps, that the Twt Hill rock, being granitic, must have been buried deeply when formed, and have required a long time for the denuding forces to reach it. But this would not be a just inference, when we remember that quite as granitic a rock is found in the Ponza Isles in association with surface volcanic materials, which are probably exceptionally bad conductors of heat.

The association of these three types of rock in one small area, granite, quartz felsite, and stratified volcanic materials, calls to mind very forcibly the similar association at St. Davids, and the upper part has by Professors Bonney and Hughes and Dr. Hicks been referred to the Pebidian. The actual similarity of the individual rocks is not very striking, but it is certainly greater than the similarity between the Pebidian and any rocks of volcanic origin in Anglesey. My correlation of the Pebidian with the latter instead of with these depended upon the general stratigraphical evidence that the Pebidians could not be Cambrian, and that these rocks partly are. In this I was probably wrong; but if so, then, as it is impossible to create a separate "system" for these Carnarvonshire rocks, jambed in as they are between higher Cambrian and Monian, both they and the Pebidian will have to be brought into the Cambrian as basal deposits.

The great porphyry rib from Moel Tryfaen to Llyn Padarn must now be considered. Here again it was Prof. Hughes who first suggested in 1877 that the beds passed through in an adit on Moel Tryfaen might be Precambrian, and accordingly the locality was examined in the following year by Dr. Hicks, who adopted the suggestion. It should be noted that there is abundant evidence in the cleavage of the Penrhyn slates, which extends in a remarkable manner into the felsites, that there has been enormous pressure here at work,

fit to give a more or less schistose character to the most solid igneous rock. Yet the "evidence" on which Dr. Hicks "feels justified in placing the whole of the so-called altered Cambrian of Moel Tryfaen and the neighbourhood and the whole of the rocks . . . coloured as intrusive felstone and porphyry . . . . with the Precambrian rocks," is the schistosity of certain portions of a mass for which he can still find no other general name than "felstones and quartz felsites," together with "ashy" rocks of the same type, one of which, according to Prof. Bonney, is a Cambrian conglomerate. This evidence is manifestly insufficient. More convincing is Dr. Hicks's explanation of the difficulties which seem to have prevented Prof. Ramsay and even Prof. Sedgwick from perceiving that the conglomerates of Llyn Padarn and elsewhere are derived from the rocks beneath them. That they are so will probably be always henceforth acknowledged in any interpretation of the district. But as to the nature of the porphyry itself, we are left in no doubt by the examination of Prof. Bonney, whose conclusion is irresistible that "they are neither intrusive nor metamorphic in the ordinary sense of the word, but parts of ancient lava-flows which, were they of modern date, we should probably not hesitate to call rhyolites." But when we have learnt this, we have not learnt all. Even a stream of lava must flow upon something. Can we discover what that was? If it were true, according to Dr. Hicks, that the conglomerates flank it *on both sides*, the discovery would probably be hopeless. But Dr. Hicks should really have more consideration for the legs of his brother geologists than to write down such a statement without indicating where it may be verified. It has given me many a mile's weary tramp up and down the hills along their western border to find any such conglomerate, but none have I ever found. From the general slope of the whole series we should on the contrary expect to find the bed of the lava-stream on the western side; and there, as I have shown at Bryn-efail, we do find it, and see the lava tearing up and altering the underlying slate and grit now turned on end. Until this section is otherwise explained, we must admit that there are Cambrian beds below the felsite, and the conglomerate cannot, however attractive the hypothesis, be the base of the series. It is nothing wonderful that there should be a contemporaneous felsite in the Cambrian rocks; indeed the felsite of Moel Gronw is another, and I have even seen one lower in the series in the valley near Glanrafon south of Carnarvon.

The third locality includes the various exposures of igneous rock and the schistose beds on the west of the Lleyn Peninsula. With regard to the latter, there is at all events, and always has been, this common opinion, that whatever the Anglesey rocks are, these are the same. But with regard to the igneous masses, it is Dr. Hicks alone who is responsible for their Precambrian age. I have already given evidence which shows that they cannot possibly be so; to rebut which Dr. Hicks falls back on imaginary "thrusts." I say "imaginary," because no evidence has ever been given of their existence, and in one case at least—that of the Hinvain syenite

—Mr. Harker has shown that on the eastern side it is intrusive in the Ordovician slates!

The net result, therefore, at present, of recent work in N.W. Carnarvonshire, is this, that, with the exception of the western side of the Lleyn Peninsula, there is nothing proved to be Precambrian in age.

4. *Malvern.*—Of this small area I cannot speak with so much confidence, having never examined it with care. There can now be no doubt that below the ordinary Cambrians there are here two distinct groups of rocks; one, presumably the younger, according to the account of Dr. Callaway, is so like the Caradoc and Wrekin masses that, in the lack of any direct evidence, its age and relations must be determined by theirs; and the other, the main mass of schistose crystalline rocks, which, since their description by Dr. Holl, are generally admitted to be of Precambrian age. The absence from among them of any ordinary unaltered sediments, and their intimate connection with igneous masses of a foliated type, renders it probable that they are older than any other rocks in England or Wales, unless it be the equally undetermined Cornish and South Devonshire schists.

As to their origin, there are two very distinct "views" before geologists. On the one hand, Mr. Rutley regards the main mass as ordinary sediments metamorphosed into schists, and intruded upon after their formation by igneous masses. On the other hand, Dr. Callaway affirms that there are here no sediments at all, but that the whole was originally composed of massive igneous rocks of two distinct types, which interpenetrated each other in veins. These veins were then drawn out by shearing, and where this process was carried furthest, the whole rock recrystallized and produced the ordinary schists.

Without a detailed knowledge of the district, which might afford some independent criterion, one can only choose between these two accounts on general principles. It appears we may divide the rocks into three categories; the massive crystalline rocks, schistose rocks in the neighbourhood of these, and schists with no visible connection with igneous rocks. About the first of these there is no question. That shearing and resulting schistosity and mineral change may be demonstrated in some cases belonging to the second category seems proved by Dr. Callaway's observations; but that the schists and gneisses away from all obvious igneous masses are reconstructed out of the disintegrated materials of such masses would seem to require more proof than the *apparent* passage of such schists into those of the second category. Moreover, Mr. Rutley describes part of these schists as quartzites with rounded particles, and others as containing fragments of felspars—phenomena which would be impossible on Dr. Callaway's explanation. It would appear from this, that no single explanation will cover all the foliated rocks of the Malverns—and that the separation of those of one origin from those of another has yet to be worked out.

5. *Shropshire.*—According to the mapping of the Survey, and the

writings of Murchison, there was nothing Precambrian in this county. The whole of the Longmynd rocks from the Slopes of Caradoc to the Stiper stones was one continuous sequence of Cambrian rocks, of which no base was seen, and the volcanic rocks of Caradoc and the Wrekin were intrusive greenstones affecting both Ordovician and Cambrian strata. The first blow to the correctness of this interpretation came from Mr. Allport, who showed that some part of the "greenstones" in the Wrekin district were rhyolitic lava-flows, and another part in the Wrekin range itself consisted of bedded volcanic ashes. This was followed up by Dr. Callaway, who proved that beneath the Tremadoc (Shineton) shales were other Cambrian rocks lying unconformably on and therefore younger than the Wrekin rocks. Thenceforth it was clear that these volcanic rocks are in some sense Precambrian, and the same thing was proved with regard to Caer Caradoc.

This was the starting point for a search after further Precambrian formations in the district, and first it was noted by Dr. Callaway that in the Ercal there is a mass of coarsely crystalline rock of acid type and without foliation, associated with the volcanic rocks of the Wrekin. It seems to have been more or less assumed that this was not an intrusive rock; and under the influence of the theory that ordinary sediments became by metamorphosis massive crystalline rocks, it was considered, from some peculiarities in its structure, to be of such an origin and of earlier date than its surroundings. At the same time, some small patches of foliated rock were found at the south end of the Wrekin, on Primrose Hill, and these were referred to the same period as the Ercal rock, and both were correlated with the rocks of the Malvern. It may here be noted that this interpretation involves the assumption that in the same massif there can be ordinary sediments converted into massive crystalline rocks, and massive crystalline rocks converted into gneisses, at approximately the same epoch. The superior antiquity of these crystalline rocks was thought to be proved, however, by the discovery at Charlton Hill of a conglomerate, apparently forming part of the volcanic series—and in such situations as to be obviously older than the quartzite—which contained pebbles of similar crystalline rocks. A third group of micaceous schists was also indicated near Rushton, whose relation to all other rocks of the neighbourhood was obscure. The Precambrian age of all these was evidenced by their relations to the quartzite, and the Longmynd conglomerates containing their fragments. A little later a series of isolated patches on the western border of the Longmynd, which were for the most part coloured as intrusive greenstone on the Survey map, were examined by Dr. Callaway and considered to be Archæan, partly because some of them were like the old Wrekin rhyolites; partly because traces of bedding were to be found in others; and partly because a conglomerate in the Longmynd series in one place dipped away from the supposed Archæan mass, and contained some rhyolitic pebbles. The same evidence was thought to prove a synclinal in the western part of the Longmynd, by which the lower beds near their junction

with the Archæans were brought to-day, though with the aid of a fault.

With regard to the relations of the Longmynd series to the volcanic masses on the eastern side, they were stated to be separated by a fault, so that no conclusion could be drawn from observations here. About three years ago Dr. Callaway began to think that the Longmynd series itself, which had always been assumed to be Cambrian, but which, as a matter of fact, according to his observations, was everywhere separated by faults, might not, perhaps, belong to that system. The relation of the Longmynd rocks on the west of the volcanic group to the quartzite on the east not having been demonstrated, their correlation was always difficult; but even if the Longmynd were Cambrian, it seemed most probable that they represented an earlier part of it than the quartzite. The lower down, therefore, the quartzite is, the less room is there in the same system for the Longmynd rocks. Recently, according to the statements of Prof. Lapworth, the quartzite, or rather its associate, the Comley sandstone, has been shown to contain the oldest known Cambrian fauna, and therefore to be very near, if not at, the base. This would leave no room in the Cambrian for the Longmynd series, and "render their Precambrian age a matter of fair probability."

According, therefore, to these observations and views, there may be three or even four distinct Precambrian formations in Shropshire. The highest would be the "Longmyndian," isolated from all others, but containing pebbles of the next series. Then the volcanic group or "Uriconian," isolated from the Longmyndian, and giving no clear stratigraphical indications of its relations to the next, but containing pebbles of it in its conglomerates; and then the "Malvernian," regarded as the oldest and most metamorphosed of all. In some undefined position with relation to these is a mass of schists (which has not yet been called the "Rushtonian"!)

I have now to state the bearing of my recent researches in the district on these conclusions. From what I had seen previously of the Longmynd and Wrekin, and what I had learned elsewhere, I had accepted the conclusion that the "Uriconian" rocks were older than the "Longmyndian," and having suggested that the latter were Upper Monian, the former became Middle Monian, and, as I then thought, in part equivalent to Pebidian; and I thought to find evidence of the correctness of this view, which differed only, if at all, from that of Dr. Callaway, in assigning a definite age to the Longmynd group. But facts are stronger than views. In studying the Longmynd series I found there was on the whole great regularity, in the lower part; but that, on reaching the conglomerates and grits, great irregularity was displayed. While the eastern members of the series marched straight across hill and dale, scoring the slopes with the edges of vertical beds, the western portion commenced with horizontal boundary-lines, and displays of outliers and inliers; in a word, there was an unconformity between the grits and conglomerates on the west and the underlying slates and greywackés on the east, the latter coming in contact with different subdivisions of the former,

even down to the lowest. Now it is only this upper series that has been shown by Dr. Callaway to contain so many rhyolite pebbles. This alone, then, is necessarily younger than the Uriconian. At the same time, the title "Longmyndian" ceases to be applicable to the whole; and if the upper part be Cambrian, there seems no reason to disturb the existing terminology, which makes the "Longmynd group" part of that system. But the Cambrian age of even this upper part requires to be proved, if it be cut off by a fault and bent into a synclinal on the west, as described by Dr. Callaway. This point was, therefore, next examined. I could find no continuous fault, but only a local one near Lyds Hole, in the neighbourhood of which is the only reversed dip in the district; elsewhere it is steadily towards the west, and everywhere the upper grits are succeeded on the dip by pale shales, continuing up to the conformable Stiper stones. Thus the series is conformable and continuous from the Stiper stones downwards to the lowest grits, and hence we are thoroughly justified in calling the latter Cambrian. I had, however, to satisfy myself of the nature of the small exposures of rock which had been referred to the Archæan by Dr. Callaway. They were all examined with care, and evidence obtained, and elsewhere recorded, that they were none of them really Archæan, or had anything to do with Precambrian rocks.

The division of the Longmynd by an unconformity into an upper or "Cambrian" series, and lower, or "Upper Monian" series, has another, and unexpected result: it leaves the relative ages of the Upper Monian and Uriconian undetermined, and this had next to be investigated. If the two were really separated by a fault, it would be hopeless; but I found that though a fault does run in the valley between Caer Caradoc and Church Stretton, it does not affect the relation sought for, and the two groups do actually come side by side, and there is a fourfold evidence that the Uriconian is the younger. 1. They come together along a very curved and crooked line, not to be accounted for by faults. 2. The Monian beds are here very fine slates, and not in any way derived from the underlying beds, as they should be if younger. 3. They are much altered near the line of junction. 4. Portions of them are caught up amongst the volcanic rocks. Although the last two statements are the best interpretations of phenomena rather than indisputable facts, all four reasons together can leave little doubt that the Uriconian are the younger rocks. In saying this I am changing former "views" on account of actual evidence, and the change is far-reaching. The notion that the Uriconian corresponds with any part of the rocks of Anglesey (except the Beaumaris rocks) must be given up, and they must be compared with the rocks of Bangor, as has been done by Prof. Bonney. Lying as they are thus shown to do between Monian and Cambrian, their classification is a matter of "view" only. My own is that they belong to the interval between the two systems, and it is a matter of indifference with which they are bracketed. The evidence from other districts is conflicting, even if we are justified in assuming the correctness of our correlations. The Pebidians at St. Davids, like the Uriconian (their equivalent), are sharply marked

off from the overlying Cambrian; the Bangor beds are not marked off by any great interval. But on both these points there are differences of opinion. Pending therefore further evidence, one "view" is as good as another. My own at present tends rather to give more weight to the Bangor succession than to the St. Davids, and to classify the Uriconians, if they *must* be classified, with the overlying though unconformable Cambrians. There remain the gneisses and massive igneous rocks of the Wrekin and the Rushton schists. But here again we have nothing but "view." Both are certainly older than the Cambrian quartzite, but are they older than the Uriconians? As to the Rushton schists, there is no positive evidence whatever. They are most like some rocks in Anglesey of any I know, and I therefore *think* they are older even than the Longmynd, *a fortiori* than the Uriconian. In the Wrekin itself there is too much faulting at the junction of the eurite with the rhyolites for any positive evidence to be produced; but I *think* the former is intrusive in the latter, because of its mode of occurrence, and because other small patches like it are found isolated in the rhyolites like intrusive bosses. At Charlton Hill, Dr. Callaway, as before noted, has found conglomerates which, if they were part of the Uriconian, would prove these to be the younger by containing eurite pebbles; but according to my observations these conglomerates are merely superficial, and probably belong to the lowest Cambrian, so that evidence fails us. As to the gneiss of Primrose Hill, it is such a tiny patch, and is associated with another tiny patch of hornblende schist, that it seems impossible to have been formed on the spot; and my "view" accordingly is that these patches are masses of lower rock brought up in the eruption of the eurite. All I feel sure of, however, is that the contrary supposition is no more than a "view."

6. *Devonshire and Cornwall.*—In this area we have mica and hornblende schists which are considered by Prof. Bonney and Gen. McMahon to be Precambrian stratified rocks. By Mr. Teall and others they are thought to be dynamically metamorphosed igneous rocks. I do not know the district at all, though I hope to study it shortly. If, however, as Prof. Bonney says, some of the rocks bear a striking resemblance to the chloritic schists of Holyhead, this would be a justification of the view that they are really Lower Monian, if it were safe to judge by mineralogical similarity alone.

Such is the present state of the knowledge acquired on Precambrian rocks in England and Wales. Probably few of the conclusions above stated are universally accepted, which is not perhaps to be wondered at, as no conclusions could possibly be stated that are.

What I have here given have been arrived at by making further observations to test the hypotheses which have been suggested to others by a smaller number of facts. Where these further observations have led to different conclusions, the latter can only be legitimately overthrown, by proving that these observations are wrong, or by making still further ones in the several districts. It will be only a waste of time to reiterate old statements which have been thus tested and found wanting.

VI.—Fossil Types in the Bristol Museum.

By E. Wilson, F.G.S.;
Curator of the Bristol Museum.

OF "those precious specimens called 'types' which must be appealed to through all time to determine the species to which a name was originally given,"[1] Bristol Museum contains one hundred and eighty six distinct fossil forms. With the exception of a single Coal-measure plant, these are all the remains of animals, ranging in the zoological scale from the Reptilia to the Actinozoa, and stratigraphically from the Silurian to the Cretaceous epochs.

Many of these types possess for the student of British palæontology a very high interest, not only on account of the remarkable nature of the fossils themselves, but also from the fact of their having been described by some of the most distinguished of palæontologists. Amongst the "historic types" in the Bristol Museum may be specially noticed the following: The "types" described by Louis Agassiz in his great work the "Poissons Fossiles," comprising the teeth and fin-spines of Selachian fishes from the lower beds of the Carboniferous Limestone of the Avon Gorge near Bristol, the teeth of the original *Ceratodi* from the Rhætic "bone-bed" of Aust Cliff on Severn, and some interesting Jurassic fishes from various localities. The remarkable and indeed unique British series of reptilian remains derived from the Upper Triassic conglomerates fringing the Durdham Down at Redland, Bristol, originally described by Messrs. Riley and Stutchbury in the Transactions, and also more recently by Huxley in the Quarterly Journal of the Geological Society of London, under the generic names *Thecodontosaurus* and *Palæosaurus*, but in regard to which we have yet much to learn. And a considerable portion of the Mollusca, etc., from the Upper Greensand of Blackdown, Devon, described by James de Carle Sowerby in Dr. Fitton's Memoir "On the Strata between the Chalk and the Oxford Oolite in the South-east of England."

Of the "fossil types" in the Bristol Museum which have been determined in more recent years may be mentioned: That remarkably rich and varied series of the teeth of *Ceratodus*, 350 in number, collected from the Rhætic "bone-bed" of Aust Cliff by the indefatigable Higgins, and acquired for this Museum through the liberality of a number of friends and patrons of the Institution in the year 1873; the Inferior Oolite Gasteropoda from Dundry and Dorsetshire, so admirably described by the late Mr. E. B. Tawney, a former Curator of this Museum, in the Proceedings of the Bristol Naturalists' Society; a series of Inferior Oolite Pelecypoda ably described by the Rev. G. F. Whidborne; and a series of Upper Silurian Mollusca from Rhymney, near Cardiff, by Professor W. J. Sollas, in the Quarterly Journal of the Geological Society.

[1] W. H. Flower, LL.D., F.R.S., Presidential Address to the British Association for the Advancement of Science, Newcastle, 1889.

In Bristol Museum also are preserved the type-specimens of some of the Enaliosaurian reptiles, which have at different times been described by Owen, Stutchbury, Sollas and Lydekker, a small number of the molluscan types of James Sowerby, Stutchbury, and Hudleston, and a few Brachiopods of Davidson and Crinoids of Austen.

The plan adopted in this Catalogue will be as follows: the types from rocks of all ages will be arranged under their zoological classes in alphabetical order. Actual "types" only will be quoted in the first list, but to this there is appended a list of described and figured specimens in this Museum which are not original types.[1] The names —generic and specific—*originally* applied will in all cases be given in the leading place, the intention being to furnish a complete record of the fossil types in this Museum under their *original* names. When, however, owing to the progress of palæontological knowledge, the name either of the genus or of the species has been changed, or when the advisability of retaining the original or a later name has been questioned, such later names will also be given, the name here adopted coming last. No new revision will be attempted in this list, but a few names, generic and specific, which are now for the first time queried, will be placed in inverted commas, and certain obvious rectifications will be made, and doubtful points considered, especially in relation to the horizons and localities from which certain of these type-specimens have been derived.

The individual type-specimens only, which are at the present time in the Bristol Museum, will be specified, and the anatomical nature of these will be indicated. Thus the Catalogue will show exactly which of the original type-specimens are, and which are not now in this Museum,[2] and also of what these consist. The original reference to every type-species will be given, and the more important of the later references, where modifications in the original nomenclature have been proposed, or which are considered of special value in corroboration of same, but a detailed "synonymy" is not attempted. In regard to the described specimens, as a general rule, only "described and figured specimens" will be noticed, and references will be given only to the works where such specimens are described. A list of the principal works which relate to the fossil type and described specimens in the Bristol Museum is appended.

Reptilia.

Ichthyosaurus Conybeari, R. Lydekker. Geol. Mag. Dec. III. Vol. V. (1888), p. 311, and Cat. Foss. Rept. B.M. (1889), p. 53 [skeleton]. L. Lias, loc. doubtful.

Note.—In the British Museum Catalogue (*op. cit.*) the original specimen, on a cast of which this type was founded, is stated to have

[1] In the Bristol Museum, the type-specimens are indicated by a little disc of yellow paper marked Typ., and described specimens other than types by a similar disc of green paper marked Des.

[2] It is unfortunately the fact that certain type-specimens have disappeared from the Bristol Museum.

come from "Saltford, near Bath," but in an old Bristol Museum Catalogue it is given as from "Banwell, Somerset."

Ichthyosaurus latimanus, R. Owen, Rep. Brit. Assoc. for 1839 (1840), p. 123 [? two skeletons]. L. Lias, Banwell, Somerset.

Note.—According to Lydekker, *loc. cit.*, this type of Owen's was founded upon two specimens in the Bristol Museum, one of which is an example of *Ich. communis*, Conybeare, whilst the other is the type of *Ich. Conybeari*, Lydekker, *vide supra*.

Ichthyosaurus ? *thyreospondylus*, R. Owen, Rep. Brit. Assoc. for 1839 (1840), p. 124; J. Phillips, Geol. of Oxford, p. 307; ? *Ich. thyreospondylus*, Phillips (ex Owen); R. Lydekker, Cat. Foss. Rept. B.M. pt. ii. p. 34 [17 detached vertebræ]. Form. and loc. doubtful.

Note.—In an old Bristol Museum Catalogue these vertebræ are stated to have come from the "Lower Lias of Lyme Regis," but Phillips, *loc. cit.*, suggests that the type-specimens were derived from the "Kimmeridge Clay of Weymouth," where this form is not uncommon. This latter view seems probable, and it may be mentioned that there is an entire absence of the usual characteristic Liassic matrix adhering to these vertebræ.

Palæosaurus cylindrodon, H. Riley and S. Stutchbury, Trans. Geol. Soc. ser. ii. vol. v. p. 352, pl. xxix. f. 4; R. Owen, Palæontology, 2nd ed. p. 276 (*P. cylindricum*, Proc. Geol. Soc. vol. ii. p. 397); T. H. Huxley, Q.J.G.S. vol. xxvi. p. 43, pt. iii. f. 3 [fragmentary tooth]. U. Trias (dolomitic conglom.), Redland, Bristol.

Palæosaurus platyodon, H. Riley and S. Stutchbury, Trans. Geol. Soc. ser. ii. vol. v. p. 352, pl. xxix. f. 5, and Proc. Geol. Soc. vol. ii. p. 397; *Thecodontosaurus*, T. H. Huxley, Q. J. G. S. vol. xxvi. p. 43, pl. iii. fs. 1, 2, 5-8; R. Lydekker, Cat. Foss. Rept. B.M. pt. i. p. 174, f. 20 [tooth]. U. Trias (dolom. conglom.), Redland, Bristol.

Plesiosaurus brachycephalus, R. Owen, Rep. Brit. Assoc. for 1839 (1840), p. 69; syn. (adult form) of *Pl. macrocephalus*, Owen (ex Conybeare), R. Lydekker, Cat. Foss. Rept. B.M. pt. ii. p. 266 [skeleton]. L. Lias, Bitton, Gloucestershire.

Plesiosaurus Conybeari, W. J. Sollas, Q. J. Geol. Soc. vol. xxxvii. p. 440, pl. xxiii. and pl. xxiv. [skeleton, with casts of dorsal vertebræ and skull]. L. Lias, Charmouth.

Plesiosaurus costatus, R. Owen, Rep. Brit. Assoc. for 1839 (1840), p. 80; R. Lydekker, Cat. Foss. Rept. B.M. pt. ii. p. 282 [anterior cervical vertebræ]. ? Rhætic (bone bed), Aust Cliff.

Plesiosaurus megacephalus, S. Stutchbury, Q. J. Geol. Soc, vol. ii. p. 411, pl. xviii.; W. J. Sollas, Q.J.G.S. vol. xxxvii. p. 472; *Thaumatosaurus*, R. Lydekker, Cat. Foss. Rept. B.M. pt. ii. p. 166 [skeleton]. L. Lias, Street, Somerset.

Plesiosaurus rugosus, R. Owen, Rep. Brit. Assoc. for 1839 (1840), p. 82; *Eretmosaurus*, R. Lydekker, Cat. Foss. Rept. B.M. pt. ii. p. 249 [vertebræ]. Rhætic or ? "L. Lias." Aust Cliff.

Plesiosaurus subtrigonus, R. Owen, Rep. Brit. Assoc. for 1839 (1840), p. 77 [vertebræ]. L. Lias, Weston, near Bath.

Thecodontosaurus antiquus, J. Morris, Cat. Brit. Foss. 1st ed. p. 211, 2nd ed. p. 354; R. Owen, Palæontology, 2nd ed. p. 275; R. Lydekker, Cat. Foss. Rept. B.M. pt. i. p. 175; *Thecodontosaurus*, sp., H. Riley and S. Stutchbury, Trans. Geol. Soc. ser. ii. vol. v. p. 349, pl. xxix. fs. 1-3; T. H. Huxley, Q.J.G.S. vol. xxvi. p. 43, pl. iii. fs. 1, 2 [left ramus of mandible with teeth]. U. Trias (dolom. conglom.), Redland, Bristol.

Note.—The types of the genera *Thecodontosaurus* and *Palæosaurus* in this Museum were founded on teeth, but associated with these teeth are numerous bones—vertebræ, ribs, pelvic, and limb-bones—many of which were described and figured by Riley and Stutchbury, and a few by Huxley. In two cases in the Bristol Museum, with many other undescribed bones, most if not all of these will be found; I have identified the following; Riley and Stutch., *op. cit.*,

pl. xxix. fs. 1, 4, 5, 6, 7, 8, 9, 10, 11; pl. xxx. fs. 1, 2, 3, 5, 6, 8, 9, 10, 11; Huxley, *op. cit.* pl. iii. fs. 1, 2, 3, 5, 6.

Pisces.

Acrodus leiopleurus, L. Agassiz, Poiss. Foss. vol. iii. p. 145, pl. xxii. f. 5; A. S. Woodward, Geol. Mag. Dec. III. Vol. IV. (1887), p. 102, and Cat. Foss. Fish. B.M. pt. i. p. 295 [tooth]. ? Forest marble, ? loc. ? Gloucestershire.

Acrodus minimus, L. Agassiz, Poiss. Foss. vol. iii. p. 145, pl. xxii. fs. 6, 10; A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 282 [teeth]. Rhætic (bone bed), Aust Cliff.

Acrodus nobilis, L. Agassiz, Poiss. Foss. vol. iii. pp. 140, 144, pl. xxi.; A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 283 [incomplete dentition]. L. Lias, Lyme Regis.

? *Asteracanthus "Stutchburyi,"* L. Agassiz, Poiss. Foss. vol. iii. p. 177 (name only). Syn. of *Ast. verrucosus*, P. M. G. Egerton, Ann. Mag. Nat. Hist. 2nd ser. vol. xiii. (1854), p. 433; Brit. Org. Rem. Mem. Geol. Surv. dec. viii. pl. ii. [dorsal spine]. Form. and loc. unknown.

Note.—For want of any figure or description in the "Poissons Fossiles," it is not certain, although it appears highly probable, that the above was Agassiz's MS. type. Mr. A. S. Woodward considers this specimen as probably synonymous with *Ast. verrucosus*, Egerton, which in the above-mentioned event must therefore replace Agassiz's name. The specimen in the Bristol Museum is labelled "Charmouth," and is stated in an old catalogue to have come from the "Lias" of that place. The slab of stone on which this spine rests is a very dense grey shelly limestone; certainly not Liassic. Tawney considered it to be Purbeck, and in connexion with this it may be observed that *Ast. verrucosus* is a Purbeck type, and according to Sir Philip Egerton is not uncommon in the Purbeck of Swanage and the neighbourhood.

Ceratodus altus, L. Agassiz, Poiss. Foss. vol. iii. p. 130, pl. xx. fs. 2-5: *C. polymorphus*, L. C. Miall, Siren. and Crossopt. Ganoids, p. 28; syn. of *C. latissimus*, Agass. (*op. cit.* vol. iii. p. 131), A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 26 [tooth]. Rhætic (bone bed), Aust Cliff.

Ceratodus curvus, L. Agassiz, Poiss. Foss. vol. iii. p. 131, pl. xx. f. 10; *C. polymorphus*, L. C. Miall, Siren. and Crossopt. Ganoids, p. 28; syn. of *C. latissimus*, Agass., A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 26 [tooth]. Rhætic (bone bed), Aust Cliff.

Ceratodus emarginatus, L. Agassiz, Poiss. Foss. vol. iii. p. 133, pl. xx. f. 11; *C. polymorphus*, L. C. Miall, Siren. and Crossopt. Ganoids, p. 28; syn. of *C. latissimus*, Agass., A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 27 [tooth], Rhætic (bone bed), Aust Cliff.

Ceratodus latissimus, L. Agassiz, Poiss. Foss. vol. iii. p. 131, pl. xx. fs. 8, 9; *C. polymorphus*, L. C. Miall, Siren. and Crossopt. Ganoids, p. 28; *C. latissimus*, Agass., A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 26 [two teeth]. Rhætic (bone bed), Aust Cliff.

Ceratodus parvus, L. Agassiz, Poiss. Foss. vol. iii. p. 132, pl. xx. f. 1; L. C. Miall, Siren. and Crossopt. Ganoids, p. 29, pl. v. fs. 4, ? 8, ? 9, 10; A. S. Woodward and C. D. Sherborn, Brit, Foss. Vert. p. 27 [tooth]. Rhætic (bone bed), Aust Cliff.

Ceratodus planus, L. Agassiz, Poiss. Foss. vol. iii. p. 132, pl. xx. fs. 6, 7; *C. polymorphus*, L. C. Miall, Siren. and Crossopt. Ganoids, p. 28; syn. of *C. latissimus*, Agass., A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 27 [tooth]. Rhætic (bone bed), Aust Cliff.

Ceratodus polymorphus, L. C. Miall, Siren. and Crossopt. Ganoids, p. 28, pl. ii. fs. 1-13; pl. iii. fs. 1 *a*, *b*, *c*, 2. 5 *a*, *b*, *c* pl. iv. fs. 1-11, pl. v. fs. 1 *a*, *b*; syn. of *C. latissimus*, Agass., A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 27 [numerous teeth]. Rhætic (bone bed), Aust Cliff.

Chalazacanthus verrucosus, J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 371, pl. xlviii. f. 13 [fin spine]. Carb. Limest. (black rock), Avon Gorge, Clifton, near Bristol.

Chomatodus (*Psammodus*) *cinctus*, L. Agassiz, Poiss. Foss. vol. iii. p. 107, pl. xv. fs. 13, 15, 16, 17. Undetermined anterior teeth of Cochliodont Sharks, A. S. Woodward, Cat. Foss. Fish. B. M. pt. i. p. 218 [teeth]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Chomatodus (*Psammodus*) *linearis*, L. Agassiz, Poiss. Foss. vol. iii. p. 108, pl. xii. fs. 5, 7—13. *Petalodus* (*Chomatodus*) *linearis*, Agass., A. S. Woodward, Cat. Foss. Fish. B. M. pt. i. p. 45, as to specimens, fs. ? 5, 9, 10, ? 11 (*supra*); *Helodus expansus*, J. W. Davis, Scient. Trans. Roy. Dublin, Soc. vol. i. ser. ii. p. 457, as to specimens, fs. 7, 8, 12, 13 (*supra*). [teeth]. Carb. Limest. (black rock), and L. Limest. Shales (bone bed), Avon Gorge, Clifton.

NOTE.—The specimens fs. 9 and 10 *supra* are from the L. L. Shales, fs. 7, 8, 12, 13, from the Carb. Limest.

Cladodus Milleri, L. Agassiz, Poiss. Foss. vol. iii. p. 199, pl. xxii*b*. f. 22; syn. of *Cladodus mirabilis*, Agass., A. S. Woodward, Cat. Foss. Fish. B. M. pt. i. p. 16 [tooth]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Cochliodus (*Psammodus*) *contortus*, L. Agassiz. Poiss. Foss. vol. iii. p. 115, pl. xiv. f. 22, and fs. 24, 27, 33; (pars) syn. of *Tomodus convexus*, Agass. MS., J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 446, as to f. 24 (*supra*), A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 191; (pars) syn. of *Deltoptychius gibberulus*, Agass. MS. J. W. Davis, op. cit. p. 435, as to f. 33 (*supra*); A. S. Woodward, op. cit. p. 214; (pars) syn. of *Psephodus*, sp. as to f. 22 (*supra*) [teeth]. Millstone Grit, Honeypen Quarry, Brandon Hill, Bristol. Carb. Limest. Avon Gorge, Clifton.

NOTE.—Specimen f. 22 is from the Millstone Grit, the remainder from the Carb. Limest.

Ctenacanthus brevis, L. Agassiz, Poiss. Foss. vol. iii. p. 11, pl. ii. f. 2; J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 337 [dorsal spine]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Ctenacanthus major, L. Agassiz, Poiss. Foss. vol. iii. p. 10, pl. iv. fs. 1, 2; J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 334 [dorsal spine]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Cyclarthrus macropterus, L. Agassiz, Poiss. Foss. vol. iii. p. 382, pl. xliv. f. 1; *Tectospondyli incertæ sedis*, A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 156 [fragments of pectoral fin]. L. Lias, Lyme Regis.

Gyronchus oblongus, L. Agassiz, Poiss. Foss. vol. ii. pt. ii. p. 202, pl. lxix*a*. fs. 10, 11; *Mesodon*, K. A. von Zittel, Handb. Palæont. vol. iii. (1889), p. 247; A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 120 [vomer]. Stonesfield Slate, Stonesfield.

NOTE.—In Morris's Cat. British Fossils, 2nd ed. p. 344, we find the following:—"*Scaphodus*, Agassiz, 1845? *Gyronchus*, Agassiz; *heteromorphus*, Ag., Bristol Museum, Gr. O. Stonesfield." The type specimen of *Gyronchus oblongus*, Agass., in the Bristol Museum was formerly labelled *Scaphodus heteromorphus*, Ag., and this was evidently the origin of the above. In the "Poissons Fossiles" I find no reference to any such form as *Scaphodus heteromorphus*, and know nothing of any such name, nor any authority for considering it synonymous with *Gyronchus oblongus*, Agass.

Helodus (*Psammodus*) *gibberulus*, L. Agassiz, Poiss. Foss. vol. iii. p. 106, pl. xii. f. 1; A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 93; undetermined anterior teeth of Cochliodontidæ, A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 219 [teeth]. Carb. Limest. Avon Gorge, Clifton.

Helodus (*Psammodus*) *lævissimus*, L. Agassiz, Poiss. Foss. vol. iii. p. 104, pl. xiv. fs. 8. 11, 13, 14, 15; A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 181. *Psephodus* as to fs. 8, 11, 13, 14, ? *Tomodus* as to f. 15 [teeth]. L. Limest. Shales (bone bed), Avon Gorge, Clifton.

Helodus (*Psammodus*) *subteres*, L. Agassiz, Poiss. Foss. vol. iii. p. 105, pl. xii. f. 4; *Orodus*, J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 399, pl. i. f. 15; syn. of *Orodus ramosus*, Agass., "a much abraded tooth," A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 231 [tooth]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Helodus (*Psammodus*) *turgidus*, L. Agassiz, Poiss. Foss. vol. iii. p. 106, pl. xv. fs. 5-12; A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 95;

undetermined anterior teeth of *Cochliodontidæ*, A. S. Woodward, Cat. Foss Fish, B.M. pt. i. p. 218 [teeth]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Hybodus apicalis, L. Agassiz, Poiss. Foss. vol. iii. p. 43, pl. x. f. 22; non *Hybodus apicalis*, Agass, op. cit. vol. iii. p. 195, pl. xxiii. fs. 16-20; A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 301 [dorsal spine]. Stonesfield Slate, Stonesfield.

Hybodus curtus, L. Agassiz, Poiss. Foss. vol. iii. p. 49 (described but not figured), (pars); syn. of *Acrodus Anningiæ*, Agass., E. C. H. Day, Geol. Mag. Vol. I. (1864), p. 57; A. S. Woodward, Cat. Foss. B.M. pt. i. p. 289 [dorsal spine]. L. Lias, Keynsham, Gloucestershire.

Hybodus leptodus, L. Agassiz, Poiss. Foss. vol. iii. p. 44, pl. x. fs. 2, 3 [imperfect dorsal spine]. Form. and loc. unknown.

Note.—This specimen is placed amongst the Lower Lias fishes.

Hybodus minor, L. Agassiz, Poiss. Foss. vol. iii. p. 48, pl. viii*b*. fs. 2, 3; *H. ? minor*, Agass., A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 102 [dorsal spine]. Rhætic, Pyrton Passage, Gloucestershire.

Hybodus raricostatus, L. Agassiz, Poiss. Foss. vol. iii. p. 187, pl. xxiv. f. 24; A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 257 [tooth]. Form. (Lias or Rhætic) and loc. unknown.

Hybodus reticulatus, L. Agassiz, Poiss. Foss. vol. iii. p. 50, pl. ix. f. 5 (pars); A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 266 [dorsal spine]. L. Lias, Keynsham, Gloucestershire.

Legnonotus Cothamensis, P. M. G. Egerton, Brit. Org. Rem., Mem. Geol. Surv. dec. viii. pl. vii. fs. 9, 10, pl. vii. f. 11 [imperfect head and posterior portion of trunk with dorsal and caudal fins]. Rhætic (Cotham marble), Aust Cliff, Gloucestershire.

Myriacanthus paradoxus, L. Agassiz, Poiss. Foss. vol. iii. p. 38, pl. vi. f. 6 [dorsal spine]. L. Lias, Lyme Regis.

Nemacanthus filifer, L. Agassiz, Poiss. Foss. vol. iii. p. 26, pl. vii. f. 9; syn. of *N. monilifer*, Agass., J. W. Davis, Q.J.G.S. vol. xxxvii. p. 418; A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 126 [dorsal spine]. Rhætic (bone bed), Aust Cliff.

Nemacanthus monilifer, L. Agassiz, Poiss. Foss. vol. iii. p. 26, pl. vii. fs. 10, 11 [two dorsal spines]. Rhætic, Aust Cliff.

Onchus hamatus, L. Agassiz, Poiss. Foss. vol. iii. p. 9, pl. i. f. 7; *Physonemus*, J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 370; A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 149 [polished section of fin spine]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Oracanthus Milleri, L. Agassiz, Poiss. Foss. vol. iii. p. 13, pl. iii. fs. 1, 2 [dorsal spine and natural cast of same]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Oracanthus minor, L. Agassiz, Poiss. Foss. vol. iii. p. 16, pl. iii. f. 5; syn. of *O. Milleri*, Agass. J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 528; A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 132 [fragment of dorsal spine]. Carb. Limest., Avon Gorge, Clifton.

Note.—Mr. Davis, loc. cit., erroneously states the type-specimen of *Oracanthus minor*, Agass., to be in the "Jones Collection" of the Geological Society at Burlington House.

Oracanthus pustulosus, L. Agassiz, Poiss. Foss. vol. iii. p. 9, pl. i. f. 7 [dorsal spine]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Orodus cinctus, L. Agassiz, Poiss. Foss. vol. iii. p. 96, pl. xi. fs. 1, 4; A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 230 [teeth]. L. Limest. Shales (bone bed), Avon Gorge, Clifton.

Orodus ramosus, L. Agassiz, Poiss. Foss. vol. iii. p. 97, pl. xi. fs. 5, 8, 9; A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 231 [teeth]. Carb. Limest., Avon Gorge, Clifton.

Orodus sculptus, J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 396, pl. li. f. 8; A. S. Woodward, Cat. Foss. Fish. pt. i. p. 238 [tooth]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Pholidophorus Higginsi, P. M. G. Egerton (ex Stutchbury, MS. Ann. Mag. Nat. Hist. ser. ii. vol. xiii. (1854), p. 435), Brit. Org. Rem., Mem. Geol. Surv. dec. viii. pl. vii. f. 6 [part of trunk]. Rhætic (Cotham marble), Aust Cliff.

Psammodus porosus, L. Agassiz, Poiss. Foss. vol. iii. p. 112, pl. xiii. fs. 1, 3, 5, 8, 9, 12, 14, 15, 18; syn. of *Ps. rugosus*, Agass., J. W. Davis, Scient. Trans. Roy.

Dublin Soc. vol. i. ser. ii. p. 459; A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 100 [abraded teeth]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Psammodus rugosus, L. Agassiz, Poiss. Foss. vol. iii. p. 111, pl. xii. f. 14; A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 100 [teeth]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Pycnodus ovalis, L. Agassiz, Poiss. Foss. vol. ii. pt. ii. p. 195, pl. lxxii. f. 5; syn. of *Mesodon* (*Pycnodus*) *Bucklandi*, Agass., op. cit. p. 192; A. S. Woodward, Geol. Mag. Dec. III. Vol. VI. (1889), p. 454 [vomer]. Stonesfield Slate, Stonesfield.

Sandalodus Morrisii, J. W. Davis, Scient. Trans. Roy. Dublin Soc. vol. i. ser. ii. p. 437, pl. liv. fs. 1, 2; A. S. Woodward, Cat. Foss. Fish. B.M. pt. i. p. 185 [two teeth]. Carb. Limest. (black rock), Avon Gorge, Clifton.

Saurichthys acuminatus, L. Agassiz, Poiss. Foss. vol. ii. pt. ii. p. 85, pl. lv*a*. fs. 1-5 [teeth]. Rhætic, Aust Cliff.

Squaloraja [*Spinachorhinus*] *polyspondyla*, L. Agassiz, Poiss. Foss. vol. iii. p. 381, pl. xlii.; *Squaloraia*, H. Riley, Trans. Geol. Soc. ser. ii. vol. v. p. 83, pl. iv. [imperfect skeleton with traces of integument and dermal scutes]. L. Lias, Lyme Regis.

Tetragonolepis monilifer, L. Agassiz, Poiss. Foss. vol. ii. pt. i. p. 212, pl. xx*ia*. f. 2; *Dapedius*, J. Morris, Cat. Brit. Foss. 2nd ed. p. 324; A. S. Woodward and C. D. Sherborn, Brit. Foss. Vert. p. 59 [body with portion of head]. L. Lias, Banwell, Somerset.

Cephalopoda.

Ammonites Sowerbyi, J. S. Miller, J. Sowerby, Min. Conch. pl. 213 [shell and natural cast]. Inf. Ool., Dundry.

Belemnites ellipticus, J. S. Miller, Trans. Geol. Soc. ser. ii. vol. ii. p. 60, pl. viii. fs. 14-16; J. Phillips, British Belemnitidæ, Pal. Soc. p. 97, pl. xxi. f. 53; syn. of *Bel. giganteus*, Schlotheim, Taschenb. 7, p. 70, and Petref. p. 45, no. 1, etc.; A. d'Orbigny, Pal. Franç. Terr. Jur. vol. i. p. 112 [guard with phragmacone]. Inf. Ool., Dundry.

Belemnites insculptus, J. Phillips, British Belemnitidæ, Pal. Soc. p. 45 (pars) [longitudinal section of guard and phragmacone]. L. Lias, Lyme Regis.

Hamites spinulosus, J. de C. Sowerby, Min. Conch. pl. 216, f. 1 (*Dentalium*, Miller, MS. Cat.); syn. of *Toxoceras Emericianus*, d'Orb., W. Downes, Q.J.G.S. vol. xxxviii. p. 90. Upper Greensand, Blackdown.

Gasteropoda.

Alaria angusta, W. H. Hudleston, Inf. Ool. Gast. Pal. Soc. 1888, p. 111, pl. iv. f. 2. Inf. Ool. ? loc.

Alaria Dundriensis, E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 20, pl. i. f. 5; W. H. Hudleston, Inf. Ool. Gast. Pal. Soc. 1888, p. 122, pl. v. f. 2. Inf. Ool. Dundry.

Alaria Etheridgii, E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 22, pl. i. f. 7; *Pseudalaria*, W. H. Hudleston, Inf. Ool. Gast. Pal. Soc. 1888, p. 189. Inf. Ool. near Yeovil.

Alaria trinitatis, E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 20, pl. i. f. 6; *Spinigera*, W. H. Hudleston, Inf. Ool. Gast. Pal. Soc. 1888, p. 103. Inf. Ool. Dundry.

Bellerophon dilatatus, J. de C. Sowerby, R. I. Murchison, "Silurian System," p. 627, pl. xii. f. 24 [shell divided vertically into two halves]. Up. Sil. Aymestry.

Cirrus Leachii, J. de C. Sowerby, Min. Con. pl. 219, f. 3. Inf. Ool. Coker, near Yeovil.

Cirrus nodosus, J. Sowerby, Min. Conch. pl. 219, fs. 1, 3; E. B. Tawney, Dundry Gast. p. 36. Inf. Ool. Dundry.

Note.—This type is now identified for the first time.

Cirrus pyramidalis, E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 37, pl. ii. f. 10. Inf. Ool. Dundry.

Cyclonema angulatum, W. J. Sollas, Q. J. Geol. Soc. vol. xxxv. p. 498, pl. xxiv. f. 5. Wenlock, Pen-y-lan, Cardiff.

Cyclonema simplex, W. J. Sollas, Q. J. Geol. Soc. vol. xxxv. p. 498, pl. xxiv. fs. 10, 10*a*. Wenlock, Rhymney River, Cardiff.

Euspira (*Natica*) *Dundriensis*, E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 15, pl. i. f. 3. Inf. Ool., Dundry.

Fusus clathratus, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 344, pl. xviii. f. 19; ? *Rapa*, F. Stoliczka, Cret. Gast. of S. India, p. 148. Up. Greensand, Blackdown.

Fusus quadratus, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 343, pl. xviii. f. 17; *Murex*, J. Sowerby, Min. Conch. pl. 410, f. 1 (young). Up. Greensand, Blackdown.

Fusus rigidus, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 343, pl. xviii, f. 16. Upper Greensand, Blackdown.

Fusus rusticus, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 344, pl. xviii. f. 18 (non *Fusus rusticus*, D'Orb.). Up. Greensand, Blackdown.

Holopella gracilis, W. J. Sollas, Q. J. Geol. Soc. vol. xxxv. p. 498, pl. xxiv. f. 5 [two casts in gutta percha and sealing wax]. Wenlock, Rhymney, Cardiff.

Holopella hydropica, W. J. Sollas, Q. J. Geol. Soc. vol. xxxv. p. 498, pl. xxiv. f. 4 [the original mould and two casts in gutta percha]. Wenlock, Rhymney, Cardiff.

Holopella minuta, W. J. Sollas, Q. J. Geol. Soc. vol. xxxv. p. 498, pl. xxiv. f. 6 [cast in sealing wax]. Wenlock, Rhymney, Cardiff.

Littorina gracilis, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 343, pl. xviii. f. 12; *Cerithium* (*Sandbergeria*), F. Stoliczka, Cret. Gast. of S. India, p. 264; *Cerithium*, W. Downes, Q.J.G.S. vol. xxxviii. p. 89. Up. Greensand, Blackdown.

Littorina pungens, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 343, pl. xviii. f. 5; *Phasianella*, W. Downes, Q.J.G.S. vol. xxxviii. p. 89. Up. Greensand, Blackdown.

"*Littorina*" *recteplanata*, E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 24, pl. ii. f. 6. Inf. Ool. Dundry.

Murchisonia corpulenta, W. J. Sollas, Q.J.G.S. vol. xxxv. p. 499, pl. xxiv. f. 11. Wenlock, Rhymney, Cardiff.

Murchisonia elegans, W. J. Sollas, Q.J.G.S. vol. xxxv. p. 499, pl. xxiv. f. 8. [One natural mould, and two casts in gutta percha and sealing wax.] Wenlock, Rhymney, Cardiff.

Nassa costellata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 344, pl. xviii. f. 26; *Cerithium*, d'Orbigny, Prod. vol. ii. p. 156; *Cerithium* (probably), F. Stoliczka, Cret. Gast. of S. India, p. 143. Up. Greensand, Blackdown.

Natica canaliculata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 343, pl. xviii. f. 6. Up. Greensand, Blackdown.

Natica carinata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 343, pl. xviii, f. 8; ? *Fossar*, F. Stoliczka, Cret. Gast. of S. India, p. 261; *Fossarus*, W. Downes, Q.J.G.S. vol. xxxviii. p. 89. Up. Greensand, Blackdown.

"*Nerita*" *lævigata*, J. Sowerby, Min. Conch. pl. 217, f. 1; *Monodonta*, J. Lycett, Proc. Cotts. Nat. Field Club, vol. i. p. 77; E. B. Tawney, Dundry Gast. p. 34; W. H. Hudleston, Geol. Mag. Dec. III. Vol. II. (1885), p. 52. Inf. Ool., Dundry.

Phasianella formosa, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 343, pl. xviii. f. 14; *Actæon* (probably), F. Stoliczka, Cret. Gast. of S. India, p. 409. Up. Greensand, Blackdown.

Phasianella striata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 343, pl. xviii. f. 15; *Actæon* (probably), F. Stoliczka, Cret. Gast. of S. India, p. 409. Up. Greensand, Blackdown.

Pleurotomaria distinguenda, E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 45, pl. iii. f. 2. Inf. Ool. Dundry.

Pleurotomaria "*Dundriensis*," E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 46, pl. iii. f. 3. Inf. Ool. Dundry.

Pleurotomaria "*obconica*," E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 45, pl. iii. f. 6. Inf. Ool. Dundry.

Pleurotomaria "*Sandersii*," E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 39, pl. iii. f. 1. Inf. Ool. Dundry.

Pleurotomaria "*Stoddarti*," E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 50, pl. iii. f. 5. Inf. Ool. Dundry.

Purpurina inflata, E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 12, pl. iii. f. 9; W. H. Hudleston, Inf. Ool. Gast. Pal. Soc. 1888, p. 92. Inf. Ool. Dundry.

Pyrula depressa, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 344, pl. xviii. f. 20; *Tudicla* or *Rapa*, F. Stoliczka, Cret. Gast. of S. India, p. 148. Up. Greensand, Blackdown.

Rostellaria macrostoma, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 344, pl. xviii. f. 23; *Aporrhais*, J. S. Gardner, Geol. Mag. Dec. II. Vol. II. (1875), p. 291; *Pterocerella*, J. S. Gardner, Geol. Mag. Dec. II. Vol. VII. (1880), p. 53; W. Downes, Q.J.G.S. vol. xxxviii. p. 89. Up. Greens. Blackd.

Rostellaria retusa, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 344, pl. xviii. f. 22; *Aporrhais*, J. S. Gardner, Geol. Mag. Dec. II. Vol. II. p. 52. Up. Greensand, Blackdown.

Scalaria climaspira, J. S. Gardner, GEOL. MAG. Dec. II. Vol. III. p. 109, Pl. III. Fig. 13 (in part type). Up. Greensand, Blackdown.

Scalaria pulchra, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 343, pl. xviii. f. 11; J. S. Gardner, GEOL. MAG. Dec. II. Vol. III. p. 109. Up. Greensand, Blackdown.

"*Straparollus*" *Dundriensis*, E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 35, pl. ii. f. 9. "*Discohelix*." Inf. Ool. Dundry.

Tornatella affinis, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 343, pl. xviii. f. 9; *Actæon*, d'Orbigny, Terr. Cret. ii. p. 117; *Ringinella*, Stoliczka, Cret. Gast. of S. India, p. 408. Up. Greensand, Blackdown.

Trochus Sandersii, E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 31, pl. ii. f. 4. Inf. Ool. Dundry.

Trochus sulcatus, Jas. Sowerby (non Phillips). Min. Conch. pl. 220, f. 3; *Pleurotomaria*, E. B. Tawney, Dundry Gast. p. 43. Inf. Ool. Dundry.

Trochus Winwoodi, E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 34, pl. ii. f. 8. Inf. Ool. Dundry.

"*Turbo*" *Dundriensis*, E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 30, pl. ii. f. 2. "*Amberleya*." Inf. Ool. Dundry.

Turbo ornatus, J. Sowerby, Min. Conch. pl. 240, f. 1; *Amberleya*, E. B. Tawney, Dundry Gast. p. 27. Inf. Ool. Dundry.

NOTE.—This type is now identified for the first time.

Turbo Shaleri, E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 31, pl. ii. f. 3. Inf. Ool. Dundry.

Turbo "*Stoddarti*," E. B. Tawney, Proc. Brist. Nat. Soc. n.s. vol. i. p. 29, pl. ii. f. 1. Inf. Ool. Dundry.

PELECYPODA.

Ambonychia tumida, W. J. Sollas, Q.J.G.S. vol. xxxv. p. 497, pl. xxiv. f. 9 [right valve]. Wenlock, Pen-y-lan, Cardiff.

Amphidesma? tenuistriata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 341, pl. xvi. f. 7; ? *Thracia* or *Tellina*, F. Stoliczka, Cret. Pel. of S. India, p. 111 [? left valve]. Up. Greensand, Blackdown.

Arca culmotecta, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 520, pl. xviii. fs. 1, 1*a* [left valve]. Inf. Ool. Dundry.

Arca rotundata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 8; *Barbatia*, F. Stoliczka, Cret. Pel. of S. India, p. 343 [right valve]. Up. Greensand, Blackdown.

Astarte concinna, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 341, pl. xvi. f. 15; *Eriphyla*, F. Stoliczka, Cret. Pel. of S. India, p. 285 [left valve]. Up. Greensand, Blackdown.

Astarte formosa, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 341, pl. xvi. f. 16; *Gouldia*, F. Stoliczka, Cret. Pel. of S. India, p. 285 [valves united]. Up. Greensand, Blackdown.

Astarte impolita, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 341, pl. xvi. f. 18 [valves united]. Up. Greensand, Blackdown.

Avicula anomala, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 18; *Crenatula*, F. Stoliczka, Cret. Pel. of S. India, p. 398 [left valve]. Up. Greensand, Blackdown.

Cardinia (*Pachyodon*) *abducta*, S. Stutchbury, Ann. Mag. Nat. Hist. vol. viii. (1842), p. 484, pl. x. fs. 9, 10 [both valves]. Inf. Ool. Dundry.

Cardinia (*Pachyodon*) *attenuata*, S. Stutchbury, Ann. Mag. Nat. Hist. vol. viii. (1842) p. 485, pl. x. f. 13 [valves united and fragment of a left valve]. L. Lias, Battledown, Cheltenham.

Cardinia (*Pachyodon*) *crassiuscula*, S. Stutchbury, Ann. Mag. Nat Hist. vol. viii. p. 483, pl. ix. f. 8; syn. of *Unio crassiuscula*, J. Sowerby, Min. Conch. pl. 153 [left valve]. L. Lias, Langar, Notts.

Cardinia (*Pachyodon*) *cuneata*, S. Stutchbury, Ann. Mag. Nat Hist. vol. viii. p. 484, pl. x. fs. 11, 12; *C. Listeri*, var. *cuneata*, Morris, Cat. Brit. Fos. 2nd ed. p. 190 [valves united]. L. Lias, Gloucestershire.

Cardinia (*Pachyodon*) *imbricata*, S. Stutchbury, Ann. Mag. Nat. Hist. vol. viii. p. 483, pl. ix. fs. 5, 6; *C. Listeri*, var. *imbricata*, J. Morris, Cat. Brit. Foss. 2nd ed. p. 190 [right and left valves]. L. Lias, Gloucestershire.

Cardinia (*Pachyodon*) *ovalis*, S. Stutchbury (non Mantell), Ann. Mag. Nat. Hist. vol. viii. p. 485, pl. x. f. 19 [valves united]. L. Lias, Fretherne, Gloucestershire.

Cardium Dundriense, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 524, pl. xviii. f. 8 [? right valve]. Inf. Ool. Dundry.

Corbula truncata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 341,

pl. xvi. f. 8 (non *Corbula truncata*, Sow., d'Orbigny, Terr. Cret. vol. iii. pl. 388, fs. 8-12) [right and left valves]. Up. Greensand, Blackdown.

Cucullæa formosa, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 7; W. Downes, Q.J.G.S. vol. xxxviii. p. 87 [left valves]. Up. Greensand, Blackdown.

Cypricardia filoptera, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 529, pl. xviii. fs. 19, 19*a* [valves united]. Inf. Ool. Dundry.

Cyprina rostrata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 341, pl. xvii. f. 1; *Veniella* (*Venilicardia*), F. Stoliczka, Cret. Pel. of S. India, p. 193 [right valve]. Up. Greensand, Blackdown.

Cytherea subrotunda, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 341, pl. xvii. f. 2; *Caryatis*, F. Stoliczka, Cret. Pel. of S. India, p. 161 [right valve]. Up. Greensand, Blackdown.

Gervillia gladiolus, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 516, pl. xvi. f. 7 [double shell] Inf. Ool. Dundry.

Gervillia rostrata, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 17; ? *Perna*, J. Morris, Cat. Brit. Foss. 2nd ed. p. 179; *Melina*, F. Stoliczka, Cret. Pel. of S. India, p. 400 [valves united]. Up. Greens. Blackdn.

Gryphea abrupta, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 493, pl. xv. f. 7 [left valve]. Inf. Ool. Dundry.

Gryphea Sollasii, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 495, pl. xv. f. 9 [valves united]. Inf. Ool. Dundry.

Harpax Tawneyi, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 514, pl. xv. fs. 18, 19 [2 single valves in matrix showing interiors]. Inf. Ool. Dundry.

Leda ? ambigua, W. J. Sollas, Q.J.G.S. vol. xxxv. p. 497, pl. xxiv. f. 7 [valves united]. Up. Ludlow, Cae Castle, Rhymney.

Lima antiquata, J. Sowerby, Min. Conch. pl. 214, f. 2 [valves united]. Syn. of *L. succincta*, Schlotheim, R. Tate, York. Lias, p. 365. L. Lias, Fretherne, Gloucestershire.

Lima poetica, G. F. Whidborne, Q.J.G.S. vol. xxxix. p. 511, pl. xvii. f, 9 [left valve]. Inf. Ool. Dundry.

Lima subovalis, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 342, pl. xvii. f. 21; *Radula* (*Ctenoides*), F. Stoliczka, Cret. Pel. of S. India, p. 414 [valves united]. Up. Greensand, Blackdown.

Lucina ? orbicularis, J. de C. Sowerby (Fitton), Trans. Geol. Soc. ser. ii. vol. iv. p. 341, pl. xvi. f. 13; *Limopsis*, F. Stoliczka, Cret. Pel. of S. India, p. 252 [valves united]. Up. Greensand, Blackdown.

(*To be continued.*)

NOTICES OF MEMOIRS.

LE PIEGHE DELLE ALPI APUANE. CONTRIBUZIONE AGLI STUDI SULL' ORIGINE DELLE MONTAGNE. Per CARLO DE STEFANI, Professore di Geologia nel R. Istituto di Studi Superiori di Firenze. pp. 114. Con una Carta Geologica, due Tavole di Spaccati, ed Incisioni nel Testo. (Firenze, Le Monnier, 1889.)

THE FOLDINGS OF THE APUAN ALPS. CONTRIBUTIONS TO THE STUDY OF THE ORIGIN OF MOUNTAINS. By Prof. C. DE STEFANI. With coloured Geological Map, two Tables of Sections, and Woodcuts.

THE author of this work, who has for many years studied the Apuan Alps, commences by giving a description of the different beds of which they are composed and of the fossils contained in them. The lowest strata consist of dark magnesian limestones, with numerous remains of *Orthoceras*, Crinoids, and Sponges, which are referred on general grounds to the age of the Middle or Upper Silurian. These are succeeded by peculiar bluish, bituminous limestones, technically known as '*grezzoni*,' belonging to the Middle Trias or Muschelkalk, and above these, a series of limestones, marbles and schists of the age of the Upper Trias. In this series are included

the famous statuary marbles of Carrara, and their true geological horizon, now no longer doubtful, was first determined by Prof. Stefani. Some of the limestones are in part siliceous, and there are also beds of red jasper, several mètres in thickness, which are regarded by the author as due to Radiolaria.

In places the limestones are mainly composed of Crinoidal remains, referred mostly to a single species, *Encrinus granulosus*, Münst. Following the Trias in upward succession are limestones of Rhætic or Infraliassic age; the Lower Trias, including the zones of *Psilonoti*, *Angulati* and *Arietites*; the Middle and Upper Lias; Jurassic schists with *Posidonomya ornati*, Quenst., which may probably represent the Oxford Clay; the Tithonian; Neocomian; Middle and Upper Chalk; Nummulitic limestones, clays and sands of Eocene age, represented also by serpentines, gabbros and diabases; gravels and clays of Upper Miocene age; Pliocene; Post-pliocene and Glacial deposits. References are given to the principal fossils present in these beds respectively, and they are briefly compared with synchronous deposits in other parts of Italy and elsewhere in Europe. The breaks or interruptions in this series are considered in a separate chapter, and this is followed by a table showing in a concise form the different successive zones and their characters.

No small part of the work is taken up by a detailed description of the various anticlinal and synclinal folds which form such marked features of the Apuan Alps, and the characters and course of these are well shown in the accompanying map and plates of sections. The author treats further of the displacements of beds which have been produced by foldings of the strata, and arrives at the conclusion that the greater part of these displacements does not result from an original discordance, but has been produced by movements in the beds themselves. He likewise opposes the view that the formation of the marbles and the *uralitization* of the Eocene diabases have been due to phenomena of compression, and attributes these alterations in the rocks to slow molecular changes produced or favoured by circulating waters and by the ordinary metamorphic surroundings. Jointings in the rocks, and the origin of valleys independently of faults, are likewise considered. Numerous instances are given of the partial inversion of strata which occur on the outer borders of mountain chains, which result from purely superficial phenomena, but may have nevertheless an important influence on the formation of these ranges.

The final chapter treats of the general conclusions on the origin of mountains, deduced from the Apuan Alps, but having a wider application. As the result of his observations, the author states that the secondary folds which constitute mountains are probably only the result of relatively subordinate phenomena which take effect at no great distance below the terrestrial surface, in the interior of greater and more general undulations, through compression produced by the overlying superficial strata; and in support of this view he refers to the paper of Mr. Charles Davison [1] 'On the Secular Straining of the Earth.'

[1] Geol. Mag. May, 1889, p. 220.

REVIEWS.

I.—Professor Gaudry on *Dryopithecus*.

A. Gaudry.—Le Dryopithèque. Mém. Soc. Géol. France, Paléontologie, vol. i. Mém. No. 1, pp. 11, pl. 1 (1890).

IN this interesting and important communication the learned Professor of the Paris Museum brings to notice a nearly complete lower jaw, recently obtained from the Miocene of St. Gaudens, belonging to the large Anthropoid Ape known as *Dryopithecus*.

This Ape, it may be well to mention, was previously known mainly by a very imperfect lower jaw obtained many years ago from the same deposits, and described by the late Edouard Lartet. Owing to the imperfection of that specimen, it was considered that the Dryopitheque had an extremely short symphysis to the lower jaw, and consequently that it was more specialized, and came nearer the human type than any existing Ape. The comparatively early geological horizon in which the remains of this Ape are found rendered its presumed specialization a very remarkable circumstance.

The new specimen has, however, proved that the creature was, as might have been expected from *à priori* considerations, in reality the most generalized of all the Man-like Apes. This is, indeed, rendered very clear by the four lower jaws represented in the plate accompanying Prof. Gaudry's memoir; and it will be seen from these figures that there is a very gradual diminution in the length of the symphysis of the lower jaw as we pass from the Dropitheque to the Gorilla, Chimpanzee, and, finally, Man. The long symphysis of the fossil form allies it with the lower Baboons and Monkeys; and we thus see that the Dryopitheque now definitely takes that place in the family *Simiidæ* which we should have assigned to it from its geological horizon. The relegation of this Ape to a low position induces the Professor to withdraw his suggestion that the problematical facetted flints of the Miocene of Thénay were its handiwork. R. L.

II.—The Geology of the Country near Yarmouth and Lowestoft.

By J. H. Blake, F.G.S., etc. Geological Survey Memoir. 8vo. pp. 101. Price 2*s*. (London, Kegan Paul, Trench, Trübner & Co.)

A SKETCH of the Natural History of Yarmouth and its neighbourhood, by C. J. and [Sir] James Paget, was published in 1834. That work contains but a brief reference to the geology; for, excepting in some controversial papers on recent physical changes by J. W. Robberds and R. C. Taylor, the district had up to that time received but little attention from geologists. The interest of the geology is indeed to a large extent furnished by the cliff-sections of Kessingland, Pakefield, and Corton. Accounts of these were subsequently published by Trimmer, Gunn, Wood and Harmer, Prestwich, and others; and in 1884 a detailed section by Mr. Blake was published by the Geological Survey (see Geol. Mag. April, 1885, p. 180).

Mr. Blake now gives full particulars of all the strata exposed in

the area, including also those, like the Chalk, Reading Beds and London Clay, which were identified by Prof. Prestwich from evidence obtained in a well-boring at Yarmouth. The cliffs exhibit the best sections we have in England of the "Chalky Boulder Clay," but the beds of most interest belong to the Forest Bed Series, and these are exposed at intervals along the base of the cliffs, being usually much obscured by talus.

Some notes on borings made along this coast are contributed by Mr. Clement Reid, and it is interesting to learn that traces of Crag were found below the base of the cliff at Pakefield. It seems likely also that some portion of the Crag Series is represented in the beds (120 feet thick) grouped as "Recent Estuarine Deposits" in Prof. Prestwich's record of the deep well at Yarmouth; but Mr. Blake expresses no opinion on this subject. These Estuarine deposits are surmounted by about fifty feet of Blown sand and shingle, on which the town of Yarmouth stands. The town indeed is built on an old sand-bank, which is supposed to have been isolated from the land until about A.D. 1000. A representation of this "popular tradition" is given in the Yarmouth Hutch Map, a copy of which was published by S. Woodward (History of Norwich Castle, p. 48); and Mr. Blake quotes Spelman, who says that this ground first became firm and habitable about the year 1008.

The Broads form a pleasing feature of the inland scenery. These, according to Mr. Blake, in all probability date back to the times when the main river-channels formed branches of an estuary. Tidal action then assisted in scouring out these shallow basins, and they were afterwards to some extent dammed up by bars that were formed across the outlets of the valleys in which they lie.

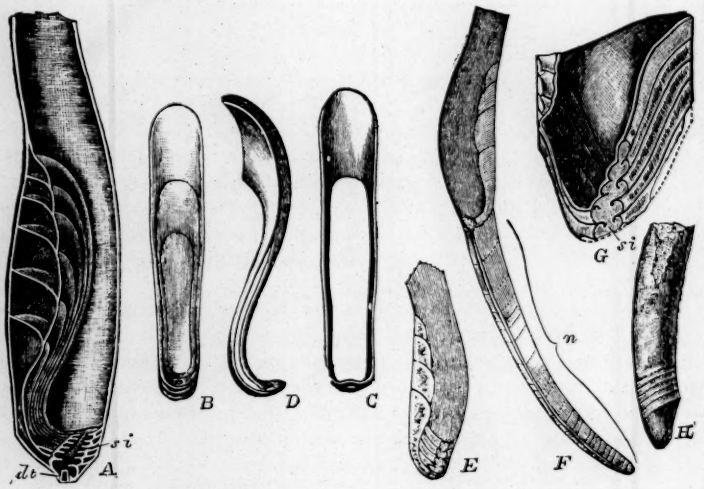
Appendices to this work include accounts of well-sections and borings, lists of fossils from the Forest Bed Series and from the Glacial Sands, and an account of the Lowestoft China, etc.

III.—The Ascoceratidæ and the Lituitidæ of the Upper Silurian Formation of Gotland. Described by G. Lindström. 40 pages and 7 plates. Communicated to the Royal Swedish Academy of Sciences, 11th December, 1889. (Stockholm, 1890.)[1]

So much of the work of the palæontologist of our day necessarily consists in revising that of his predecessors, that the appearance of a palæontological memoir, written by a master of the craft, and containing new facts and deductions, cannot fail to arouse more than ordinary interest. After long and patient research, Dr. Lindström has brought to light, from the rich Silurian deposits of Sweden, nearly the whole of the missing parts of the shell of *Ascoceras*. Though this discovery has been anticipated to some extent by the author in a paper communicated to this Magazine (December, 1888), we have in the present memoir a very complete and clear account of the structure of *Ascoceras*, and an allied new genus (*Choanoceras*) illustrated with a series of admirable plates, containing numerous figures.

[1] Written in English.

The memoir opens with an introduction, containing a description of the Cephalopoda beds of Gotland: these represent the "Ludlow beds" (190 feet), the "Wenlock shale" (80 feet), and the "Upper Llandovery" (thickness unknown). In the uppermost of these beds immense masses of the shells of Cephalopoda occur, the strata (4 or 5 feet thick) being made up almost entirely of them, in some places. From the vast quantities of these shells, of all sizes, thus heaped together, the author supposed that they were washed ashore, as the shells of *Spirula* are at the present day on the shores of the Pacific islands.



A, Schematic view of the interior of *Ascoceras manubrium*, Lindstr., showing the structure and arrangement of the septa; *si*, siphuncle; *dt*, duct that communicates with the siphuncle of the Nautiloid portion of the shell (see *n*, Fig. F); B, schematic view of three sigmoid septa of *Asc. fistula*, Lindstr., seen from the ventral side; C, view of the third septum of the same species, shown as free, as if removed from the shell, to exhibit the large central lacuna; D, the same viewed laterally (the siphuncular orifice is seen at the bottom of all these figures); E, longitudinal section of a specimen of *Asc. decipiens*, Lindstr., from Sandarfve Kulle, with four regular septa above the sigmoid ones; F, schematic view of *Asc. decipiens*, represented as if complete—*n*, the Nautiloid portion of the shell; G, longitudinal and median section from the concave to the convex side, of *Choanoceras mutabile*, Lindstr., showing the interior of the shell, with the outlines of the incomplete septa—*si*, siphuncle; H, fragment of the same species, reduced to about $\frac{1}{3}$ natural size. All the figures are copied from Lindström's plates A—D, reduced from $\frac{1}{3}$ to $\frac{1}{2}$ natural size; E—G are the same size as the original figures.

After reviewing in considerable detail the work done by various authors, chiefly German and Swedish, in connection with Gotland Cephalopoda, including Klein, Breynius, Hisinger, Schlotheim, Wahlenberg, Marklin, Angelin, Boll, and Barrande, Dr. Lindström commences his description of the Family Ascoceratidæ.[1] In this

[1] The fossils described in this memoir belong mostly, we are told, to the Palæontological Department of the Swedish State Museum at Stockholm.

family he recognizes four genera, viz. *Ascoceras*, Barrande,[1] *Glossoceras*, Barr.,[2] *Billingsites*, Hyatt,[3] and *Choanoceras*, gen. nov. These genera are united together by a structural feature common to all of them, viz. "the abnormal growth and morphology of the septa formed during the last stage of their existence." Beginning with regularly-formed septa, there are developed at a later stage of growth a series of septa which bend upwards in a sigmoid fashion against the walls of the shell, on the dorsal side. All the septa succeeding the first sigmoid one are incomplete, leaving a large "lacuna" or empty space (Figs. C, D) in the centre, which lacuna is bounded by the lateral margins of the septa. The siphuncle (Figs. A, G, *si*) is broad, with nummuloidal or bulbous elements. Truncation seems to have been repeated several times in all these genera.

Ascoceras.—This genus has two distinct stages in its development, viz. *a*, the Nautiloid; *b*, the Ascoceras proper. Stage *a* corresponds with the common type of the suborder Nautiloidea. It may be regarded, theoretically, as a long gently-curved tube (Fig. F), corresponding in curvature with the Ascoceras part of the shell; but owing to its having been broken off or decollated several times during growth its actual length seldom exceeds that of the Ascoceras portion, and it often falls short of this. The test of the Nautiloid stage (Fig. F, *n*) is generally transversely striated; sometimes annulated. The septa are oblique, shallowly concave, and higher on the dorsal than on the ventral side: they are irregularly spaced, sometimes several are placed near together, while others are wide apart. The necks of the septa[4] project backwards. The siphuncle is always situated near the ventral (convex) side; it is composed of slender, tubular elements.

The second stage of *Ascoceras*, termed by Lindström *Ascoceras proper*, is of sac- or flask-like form, slightly curved, with a narrow, cylindrical prolongation or neck, ending in a simple, circular aperture.

The internal structure requires a more detailed description, especially as Dr. Lindström's researches have revealed some new features in it. The septa are of two kinds: *a*, regular or Nautiloid septa; *b*, Sigmoid septa. The first septum, which may be regarded as the last Nautiloid septum, and forms the bottom of the shell, "is strengthened from within by organic deposits of calcareous matter." This septum is in some species followed by a second, of the ordinary shape; but in the majority of species the abnormal, sigmoid septa (Figs. A, E, F) immediately succeed the first, ordinary one. The number of sigmoid septa varies from three to seven; but

[1] Oesterr. Blätt. für Litt. u. Kunst, 1847; Haidinger's Berichte über d. Mittheil. v. Freund. d. Naturwiss. in Wien, 1847, p. 268; also Bull. Soc. Géol. France, 1855, sér. 2, vol. xii. p. 157.

[2] Syst. Sil. de la Bohême, 1867, vol. ii. pt. i. p. 372.

[3] "Genera of Fossil Cephalopods," Proceed. Boston Soc. Nat. Hist. vol. xxii. 1883, p. 278. *Billingsites* is a Silurian genus closely allied to *Ascoceras*. The type species is *Asc. Canadense*, Billings, Rep. Prog. Geol. Surv. Canada, 1853–56, p. 310.

[4] Their recurved ends which form a little funnel through which the siphuncle passes.

it is very constant in any given species.[1] The septa are continuous from the ventral (convex side) to the dorsal side, as may be seen in many of the casts,[2] where the sutures continue uninterruptedly across; in the interior of the shell, however, this continuity is broken. Here only the first sigmoid septum is entire, all the succeeding ones having a broad, elongate, elliptical empty space or lacuna, running longitudinally and slightly expanding anteriorly, in accordance with the increasing diameter of the shell (Figs. C, D). The organic deposition ceased where the septum touched the surface of the next preceding one, but the margins, where the septa were not in contact, are entire. The margins thus form a sort of frame around the central, elongated, empty space. The siphuncle (Fig. A, G, *si*), always near the ventral side of the shell, consists of broad, nummuloid elements; it is in immediate connexion with the siphuncle of the Nautiloid stage of the Ascoceras shell through a peculiar little tubular duct (Fig. A, *dt*), which is closed by a calcareous secretion, when decollation has taken place. The form and position of the septa (Fig. A) may be thus described. Starting from the dorsal wall of the shell they first make a strong, inwardly-directed curve, and then sweeping outwards in a wider curve, they closely approach the dorsal side, and finally bend round to the ventral side, thus completely encircling the shell.

Dr. Lindström considers it questionable whether there was any great change in the shape of the animal of *Ascoceras*, such as the altered form of the septa in the Ascoceras stage would lead one to suppose. That there was some change, at least in volume, he naturally infers, because it seems evident that the shell was, as it were, moulded upon the body of the animal. But he finds, in several instances, evidence of a curious reversion in the shape of the septa and siphuncle to the Nautiloid stage in the *Ascoceras*. Figure E exhibits this remarkable modification. Dr. Lindström argues from this "reversion of characters" that as the animal could scarcely "twice modify its body," there must actually have been very little change in its structure as it passed from the Nautiloid into the Ascoceras stage.

Referring to the increase in the size of the body of the animal of *Ascoceras*, as shown by the inflation of the sac-like part of its shell, Dr. Lindström remarks: "An increase in the volume of the body must also have occurred in such genera as *Gomphoceras* and *Poterioceras*, the latter of which bears no slight resemblance to *Ascoceras*. When the shell had been completed, the mollusc drew itself higher up in it and commenced the secretion of the sigmoid septa. Near the ventral side the place of the animal has not been much changed; at the dorsal, again, it moved more and more upwards."

A short history of *Ascoceras* here follows, in which the views of different authors, beginning with Barrande, are set forth and

[1] A fragment of an unknown species, figured by Dr. Lindström, has indications of no less than twelve septa.

[2] We observe that Dr. Lindström uses the term "nucleus," in the same sense; but it is scarcely so appropriate.

criticized. The author claims to be the first to have seen the "Nautiloid" portion of *Ascoceras*, and we think justly; for the specimen found in 1877 by Barrande (Syst. Sil. de la Bohême, vol. ii. Suppl. p. 98, pl. ccccxci.) with two septa beneath the first sigmoid one, regarded by him as deciduous septa, are, in fact, says Lindström, "the first two septa of the *Ascoceras*, and the lowermost of these is the truncated extremity."

The following (thirteen) new species of *Ascoceras* are described (pp. 20—33) and figured:—*cochleatum*, *dolium*, *fistula*, *pupa*, *reticulatum*, *manubrium*, *ampulla*, *collare*, *lagena*, *cucumis*, *decipiens*, *sipho*, *gradatum*. Besides these, *A. Bohemicum*, Barrande, is described and figured. Passing over *Glossoceras* and *Billingsites*, about which the author has nothing special to remark, we come to the new genus *Choanoceras*[1] (Figs. G, H) described as having a shell "resembling a faintly-curved Orthoceratite, with the lower extremity truncated and conically pointed." The aperture is probably simple; the body-chamber very large, occupying almost nine-tenths of the whole shell. Septa from four to six, formed like a pointed, oblique funnel. All the septa are equally well developed in young specimens, but in the adult, in which there are six septa, three of these are complete, and the three earlier ones incomplete or lacunose. The siphuncle is nummuloid in the older individuals, cylindrical in the younger, and the necks of the septa hook-like and strongly recurved. This genus contrasts with *Ascoceras* in the meagre development of its lacunose septa. The position of the latter may also be contrary to those in *Ascoceras*, supposing that the convex side of the shell is the ventral, and the concave the dorsal, as is assumed in *Ascoceras*. In *Choanoceras* the lacunose part of the septa is placed against the convex side; in *Ascoceras* near the concave side. One species of *Choanoceras* is described and figured, viz. *C. mutabile*.

A fragment of an unknown genus is figured by Dr. Lindström, who describes it as having "pointed and funnel-like septa; but regularly placed in the median axis of the straight shell." The necks of the septa are very long and continuous down to the bottom of the next septum, "thus forming, as it seems, the entire siphuncle." It cannot, therefore, belong to the present group.

Under the Lituitidæ, two species of *Ophidioceras* are described and figured, viz. *O. reticulatum*, Angelin, and *O. rota*, sp. nov. Of this genus Dr. Lindström observes that there is nothing to add to the generic characters given by previous authors, except that the body-chamber is of extreme length in all the Gotland specimens that have been sectioned. It occupies, namely, more than one whorl, and sometimes more than two.

Referring to the classification of the Ascoceratidæ and kindred groups, Dr. Lindström dissents from Hyatt's allocation of his (Hyatt's) genus *Billingsites* with *Mesoceras*, Barr., in the family Mesoceratidæ (Hyatt). Dr. Lindström considers that *Billingsites* should be "placed amongst the Ascoceratidæ near *Glossoceras* on account of its contracted aperture, while *Ophidioceras* may keep

[1] From χόανος a funnel.

its more natural place amongst the Lituitidæ, which has been given to it by Barrande."

We desire in closing to express our sincere appreciation of the valuable service the author has rendered to palæontological science in collecting and expounding so many new and interesting facts regarding a hitherto but half-understood genus. We trust he will permit us also to add our congratulations to him upon his admirable handling of our mother-tongue. A. H. F.

The Geology of Mont Blanc.

IV.—"Étude sur les Roches cristallins et éruptives des environs du Mont Blanc." By M. Michel-Lévy. (Bull. serv. Carte géol. France, No. 9, Paris, 1890.)

THE old view of the geological structure of Mont Blanc represented the valley of Chamounix as occupied by a synclinal of Jurassic rocks, nipped in between the schists and gneisses of the anticlinals of the Aiguilles Rouges on the west and of Mont Blanc on the east. This view has been widely circulated owing to the frequent quotation of A. Favre's diagram, in which it is so well expressed. It has not however, during the past few years, been allowed to pass unchallenged. Lory regarded the fact of the schists on the west flank of Mont Blanc dipping eastward, and those to the east dipping westward, as due simply to an ordinary synclinal, and not as a case of the "fan structure." According to this theory, the central "protogine gneiss," which forms the main mass of the mountain, is newer than the schists upon its lower flanks, while the crystalline rocks are faulted up against the Mesozoic beds of the Chamounix valley. Mazzuoli on the other hand regards Mont Blanc as an anticlinal, and the protogine as part of the old "fundamental gneiss," covered to east and west by newer but yet pre-Palæozoic schists. It is clear that in these conflicting hypotheses, the whole question turns upon the nature of the "protogine" and its relations to the surrounding schists. M. Michel-Lévy has therefore subjected this rock to a careful examination, and in the above memoir claims the protogine to be a true granite, intrusive into the schists, and subsequently itself foliated by lateral pressure. This view is supported, first, by a microscopic study of the protogine and its principal varieties, such as the amphibolic protogine, an altered specimen of which was recently described by an English author as an epidiorite. Second, by an examination of the relations of the protogine to the schists, into which it is proved to send numerous veins; the junction of the two rocks is not well shown in the great sections of the valleys of the Glacier d'Argentière and the Mer de Glace, but clear proof of the intrusive nature of the protogine can be seen above Pierre Pointue and round the Aiguille du Plan. Third, by a microscopic study of the "englobements" so numerous near the junction with the schists. M. Lévy rejects Prof. Rosenbusch's view that these are segregations of the first period of consolidation, and argues that they are included fragments of the schists.

If the valley of Chamounix be a synclinal, then there should be some agreement between the sequence of the schists on both sides of the valley. M. Michel-Lévy divides the schists into three zones. The western includes three main types: the granulitic mica-schists (*i.e.* schists injected by granulite) of the Aiguille de Berard, Aiguille côtée, the amphibolites and eclogites of Lac Cornu, and the coarse mica-schists of the Brèvent. The median zone is a series of mica-schists, which extend from the Col du Montet, past the Flégère, and below the Planpraz, along which line they form the slopes at the foot of the crags formed by the coarse schists of the first zone; very similar rocks to these occur at the end of the Glacier des Boissons. The eastern zone is constituted of mica-schists, associated with some amphibolites, and analogous to the rocks of the western zone: this zone can be well studied in the valley of the Mer de Glace, where the schists alternate with interstratified granulites, while both are cut by veins of aplite. Hence though the evidence is inconclusive, the existence of a synclinal is probable. M. Michel-Lévy hopes to obtain more satisfactory proof during the coming season.

The age of the protogine cannot be exactly determined. It is pre-Carboniferous, as fragments of it occur in the Carboniferous conglomerate of Ajoux; it is later than the pre-Cambrian schists (z^2 and probably also x of the French Survey), and so is much younger than the Italian geologists admit.

In addition to the main question discussed in the memoir, valuable contributions are made to the discussion of collateral subjects. Thus the author claims that the microgranulite of La Poya supplies conclusive evidence of the existence of the two different stages of consolidation in granitic rocks. Further that while pre-Carboniferous movements had a great influence on Alpine topography, the extent of later elevations can be seen by the foldings of the Mesozoic beds of the Charollaise and the Maçonnaise. It is also contended that the neighbouring granite of Valorcine has altered true gneiss into the schists in which it is intrusive.

In addition to the woodcuts illustrating the micro-structure of the rocks described, the memoir is accompanied by four admirable photographic views, of which those showing the Mer de Glace opposite the "Angle," and the Aiguille du Chardonnet across the Glacière d'Argentières, are especially pleasing. J. W. G.

REPORTS AND PROCEEDINGS.

Geological Society of London.

June 18, 1890.—Dr. A. Geikie, F.R.S., President, in the Chair.—The following communications were read:

1. "The Borrowdale Plumbago, its Mode of Occurrence and Probable Origin." By J. Postlethwaite, Esq., F.G.S.

After giving details of the mode of occurrence of the plumbago of Borrowdale in veins traversing diabase and diorite, which break through the Volcanic Series of Borrowdale, the author refers

to the modes of occurrence of plumbago in other regions, and contrasts these with the surroundings of the Lake-District masses. He points out that many thousand feet of volcanic rock supervened between the Borrowdale plumbago-bearing rocks and the overlying carbonaceous shales of Silurian age. On the other hand, he finds similarities between the containing rocks in Borrowdale and the diamond-bearing rocks of South Africa, and considers that the conditions under which the plumbago was formed in the Lake District approached much more closely to those which gave rise to the Kimberley diamonds than to those which originated the plumbago deposits in North America, though there is great dissimilarity in the chemical composition of the intrusive rocks in the two cases, especially with regard to the quantity of magnesia present. He suggests that the molten magma in its upward course passed through a deep-seated stratum of highly carbonaceous material, and tore off numerous fragments, the bituminous matter in which became acted upon by heat, a further alteration being subsequently caused by the intrusion of the diorite.

2. "Notes on the Valley-Gravels about Reading, with especial reference to the Palæolithic Implements found therein." By O. A. Shrubsole, Esq., F.G.S.

The following deposits containing implements are described :—

A. *North of the Thames.*

(i.) Gravel at Toot's Farm, Caversham ; 235 feet above sea-level.

(ii.) Clayey gravel by side of Henley Road, Caversham ; 168 feet above sea-level.

(iii.) Subangular gravel at Shiplake ; 200 feet above sea-level.

B. *South of the Thames.*

(i.) Gravel at Elm Lodge Estate, Reading ; 197 feet above sea-level.

(ii.) Gravel on disturbed beds at Redlands ; 157 feet.

(iii.) Comminuted flinty gravel at Southern Hill ; 223 feet.

(iv.) Gravel at Sonning Hill ; 185 feet above sea-level.

(v.) Gravel at Ruscombe, Twyford ; 165–170 feet above sea-level.

The author concludes that the highest gravels (235–280 feet above sea-level) do not, so far as is known, contain any traces of Man, and that a considerable amount of valley-erosion occurred before the deposition of the earliest gravels which have furnished human relics. Further, he considers that the deposits indicate the occurrence of a severe climate at an early stage, and its recurrence at a later one, viz. during the deposition of the gravels found at a height of 197 feet and 144 feet respectively above the sea-level. He believes that many of the implements found in the lower levels at Reading have been derived from gravels of various dates and different levels, which have been swept away by denudation, and that this will account for the mixed character of the types of implements.

The next Meeting of the Society will be held on Wednesday, November 12th, 1890.

OBITUARY.

SIR WARINGTON WILKINSON SMYTH, M.A., F.R.S.

For. Sec. Geol. Soc., F.R.G.S.; Lecturer on Mining at the Royal School of Mines, and Inspector of Mineral Property of the Duchy of Cornwall and the Crown.

BORN 1817; DIED 19TH JUNE, 1890.

Sir Warington W. Smyth (whose sudden death from heart disease we recorded in our last Number) was the eldest son of Admiral W. H. Smith, D.C.L., F.R.S., etc., and was born in 1817 at Naples. His mother was the only daughter of Mr. Thomas Warington, British Consul at that city. He was educated at Westminster and Bedford Schools and Trinity College, Cambridge, where he distinguished himself, among other ways, as an oarsman, rowing in the winning University Crew on the Thames in 1839. In this year he took his B.A. degree, and, having gained a travelling bachelorship, commenced a journey which extended over a period of more than four years, and was mainly devoted to a study of the mineral products and mining industries of Germany, Austria, Hungary, European Turkey, and Asia Minor, in the course of which he laid the foundation of that solid and practical knowledge of these subjects which made him throughout his life one of our greatest authorities upon them. On his return to England in 1844, he was appointed by Sir Henry De la Beche to a post on the Geological Survey, and in 1851, on the formation of the Royal School of Mines in Jermyn Street, he became Lecturer on Mineralogy, and on Mining, retaining the former chair till 1881, and the latter to his death. About the same time he was appointed Inspector of the Mineral Property of the Duchy of Cornwall, and soon afterwards Chief Mineral Inspector to the Crown, under the Commissioners of Woods, Forests, and Land Revenues. For the Geological Society he has done good service, having been one of the Honorary Secretaries from 1856 to 1866, President in 1866 and 1867, and Foreign Secretary for the last 16 years. In 1879 he was appointed Chairman of the Royal Commission on Accidents in Coal Mines, to the duties of which office he devoted much labour, in addition to the performance of his ordinary professional work during the seven years in which the Commission was sitting. For this and other public services he received the honour of knighthood in 1887. Besides various technical reports and contributions to purely scientific literature, he published in 1856 a book entitled "A Year with the Turks," and in 1867 "A Rudimentary Treatise on Coal and Coal Mining," a standard work now in its sixth edition, which has been translated into the principal European and also the Chinese languages. Although he was not a man who cared much to place himself before the world, he commanded the respect and esteem of all who came into contact with him in no common degree, and it will be difficult to replace him in the particular branches of Science which he had made especially his own. He may be said almost to have died in harness; for, notwithstanding that he had been for some months out of health

to such an extent as to cause anxiety in the minds of his intimate friends, he could scarcely be persuaded to give himself any relaxation from his official labours, the scrupulously conscientious performance of which had characterized him throughout life, and he attended the *soirée* of the Royal Society on June 18th, the evening before his death. Sir Warington Smyth married, in 1864, Antonia, daughter of the late A. M. Story-Maskelyne, of Basset Down, Wilts, and he leaves two sons.

As a lecturer on Mining to students he was most popular, and his discourses were amongst the most largely attended of any of those delivered at the Royal School of Mines. These lectures were never published, but a short-hand report of the course, taken by a writer employed by Prof. John Milne, F.R.S., of Tokio, Japan, when he was himself one of Prof. Smyth's students, and afterwards privately printed, exists in the archives at Jermyn Street. It would be a pleasing memorial to Sir Warington Smyth, if some of his old students undertook to reprint these (after being carefully edited), and issued them as a testimonial of their love and esteem for their Professor.

ROBERT WILLIAM MYLNE, F.R.S., F.G.S.

Born, June 14, 1816; Died, July 2, 1890.

We regret to record the death of another old member and past officer of the Geological Society of London. Mr. R. W. Mylne, F.R.S., who died on the 2nd July, 1890, in his 75th year.

By profession Mr. Mylne was a Civil Engineer and Architect, particularly directing his attention to matters concerning the Water-supply of large towns. This special bias to his career was doubtless greatly due to the fact that his father held the post for fifty years of Engineer to the New River Company. Although not himself an official of that Company, he took part in engineering work required by them, in association with his father, for about twenty years. The knowledge so obtained is shown in his evidence before the Royal Commission on Water-Supply on the 6th June, 1867, and in his paper "On the Supply of Water from Artesian Wells in the London Basin, with an account of the Sinking of the Well at the Reservoir of the New River Company at Hampstead Road;"[1] and in his work published in 1850, "Sections of the London Strata," in which many "deep wells" of those days are recorded, but none of them pass through the Chalk; the deepest being 522 feet.

About 1857 he published a Contour Map of the Metropolis, and in 1871 a similar map, geologically coloured, appeared. He was elected a Fellow of the Geological Society of London in 1848; and was on the Council of that Society from 1854 to 1868, and again in 1879. In the years 1856 and 1857 he held office as one of the Secretaries, the other being the late Sir Warington W. Smyth, F.R.S. He was elected a Fellow of the Royal Society in 1860. For many years he served the office of Treasurer to the Geological Club. W. R. J.

[1] Trans. Inst. Civil Eng. vol. iii. pp. 234–244, 1842. This includes Reports by W. C. Mylne and J. Simpson.